Mining CONGRESS JOURNAL

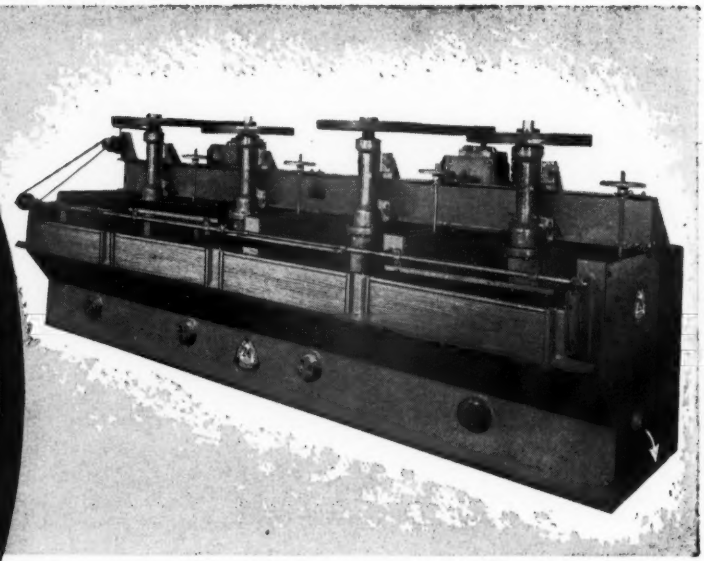
AMC

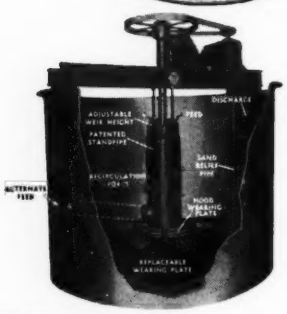
Season's Greetings

DENVER CAN SUPPLY COMPLETE EQUIPMENT FOR YOUR MILL

One Responsibility

Crushers, Screens, Feeders, Ball-Rod Mills, Classifiers, Jigs, Pumps, Samplers, Agitators, Conditioners, Flotation, Thickeners, Filters, Dryers, Ore Testing and Mill Design Services.





DENVER (patented) SUPER-AGITATOR AND CONDITIONER

- Patented standpipe gives controlled recirculation.
- All feed passes through propeller zone for complete conditioning . . . no short circuiting.
- Recirculation prevents build-up of froth on surface.
- No sanding in of propeller on shutdown.
- Sizes 3' x 3' to 20' x 20'.

For complete information, WRITE FOR BULLETIN NO. A2-B4.

HERE'S WHY DENVER "SUB-A" LEADS THE WORLD IN ECONOMIC METALLURGY

FLOTATION EFFICIENCY cannot be based on any single feature. Low tailings, clean concentrates, low horsepower, long part life, continuous operation, coarse feed, initial and operating costs and space required must be balanced to produce the greatest NET PROFIT FOR YOU.

Deco's "know-how" in flotation engineering is unequaled. The Denver "Sub-A" can be adapted to meet milling conditions instead of adapting your plant to meet limitations of the machine. These features of mechanical flexibility which your mill man needs to gain ECONOMIC METALLURGY are illustrated in Deco Bulletin F10-B81—sent on request.

Case histories of Denver "Sub-A" flotation in problems similar to yours will be sent on request. Flotation tests and flow sheet design services are available. Consultation is without obligation. Write today. Use our experience to help increase your PROFITS BY FLOTATION THE MODERN WAY.

"The firm that makes its friends happier, healthier and wealthier"

DECO ENG... DENVER EQUIPMENT 24 HOUR SERVICE COMPANY

DENVER EQUIPMENT CO.

1400 Seventeenth St. • Denver 17, Colorado

DENVER • NEW YORK • CHICAGO • VANCOUVER • TORONTO

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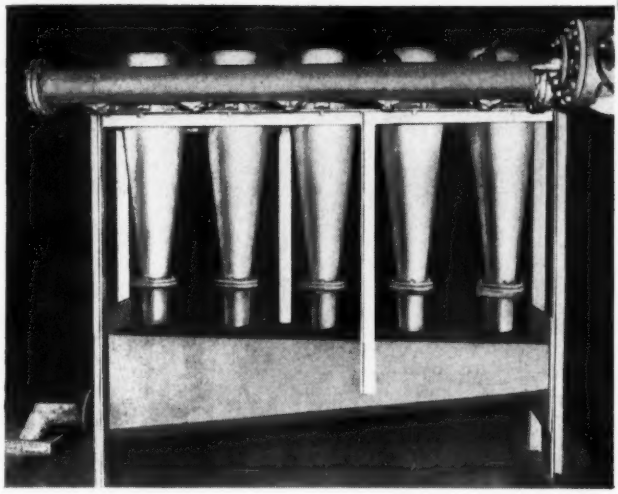
Heyl & Patterson CYCLONES



Prevent Stream Pollution from Coal Washer at World's Largest Coke and Chemical Plant

The use of Heyl & Patterson Cyclones at United States Steel Corporation's Clairton Coke and Chemical Plant coal washer provides additional water clarification facilities to maintain capacity and a closed water circuit as mining practices change. This washer has always operated with a closed water system.

H & P Cyclones contribute also to uniform functioning of the coal washing equipment by controlling washing water density.

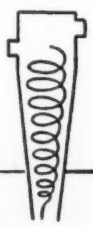
This plant has enjoyed satisfactory cyclone operations for more than 5 years. Many similar installations throughout the coal industry confirm these good results.

By eliminating all discharge to streams, sewers or ponds, Heyl & Patterson closed circuits make it easy to comply with clean stream laws.

CHECK THESE ADVANTAGES!

- ☐ Closed circuit operation
- ☐ Recovery of fine coal
- ☐ Prevention of stream pollution
- ☐ Controlled washing water densities
- ☐ Conservation of water
- ☐ Sharp classification for washing operation

Get All The Facts...
Write For Booklet CT-954



Heyl & Patterson INC.

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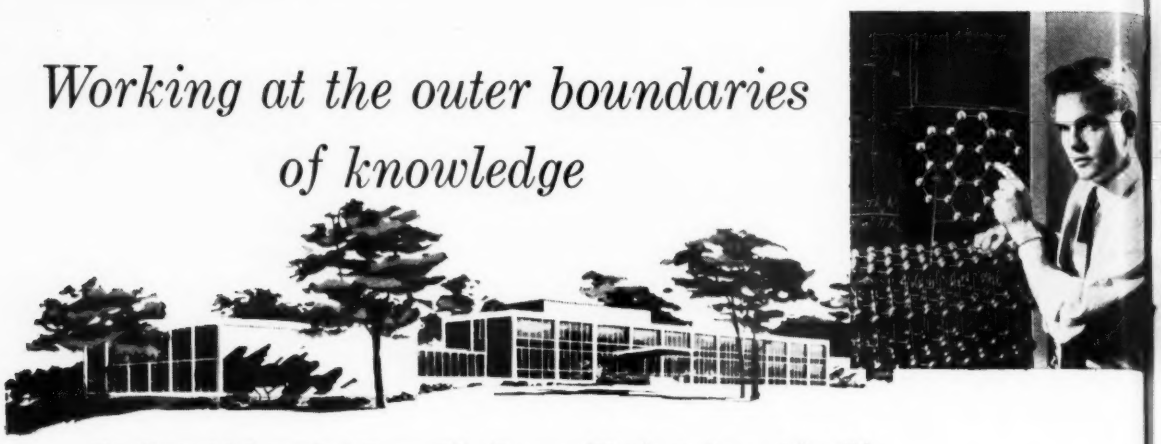
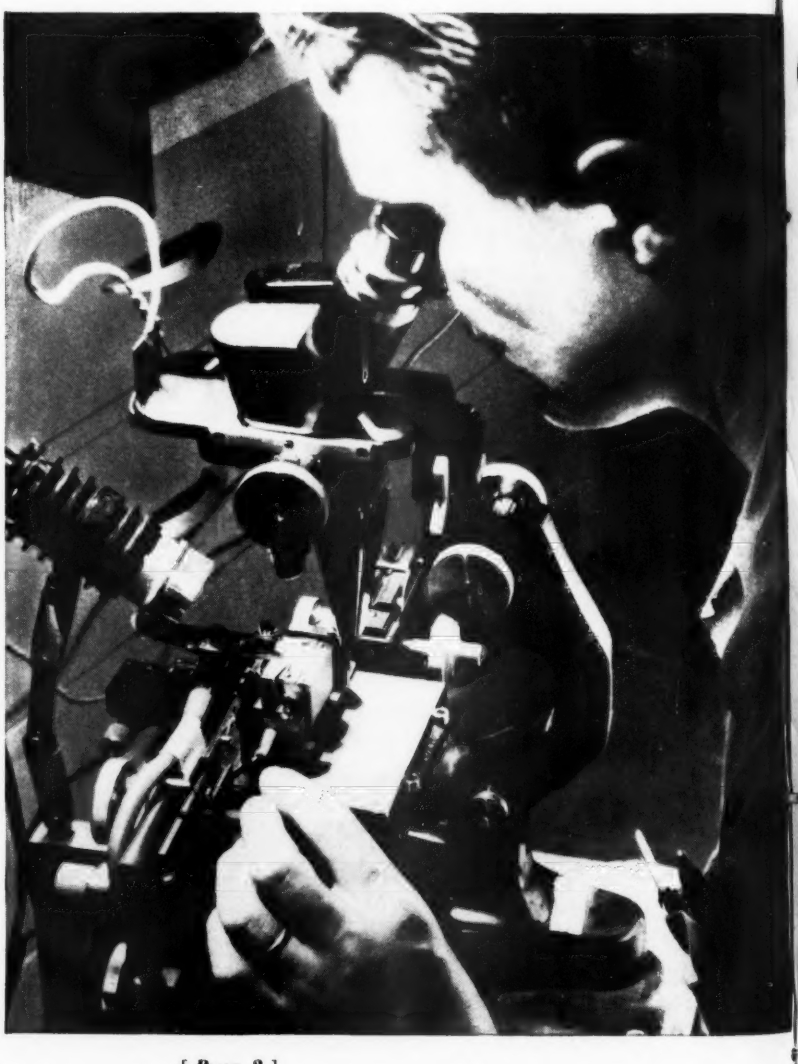
Working at the outer boundaries of knowledge



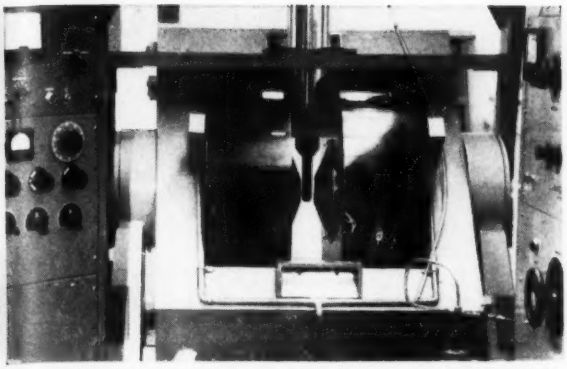
New Research Laboratories in Parma, Ohio. To expand its pioneering work in solid state and chemical physics, National Carbon Company has enlarged its staff of scientists and provided them with an ideal laboratory setup for creative work. Typical of their pioneer experimentation is current work on the "fuel cell" — a new type of battery for producing electricity directly from gases, such as hydrogen and oxygen. This is part of a far-ranging research program on all types of batteries and their carbon components.

New b

c



Mechanized tweezers handle graphite crystal. To make it into a proper experimental guinea pig, the fragile crystal must be painstakingly cut and mounted so that electrical flow can be measured along the unique crystalline directions of graphite. Experiments with pure graphite crystals are important because all materials which we know as carbon and graphite are basically composed of the same graphite crystals being prepared here. Tremendous differences in electrical behavior and other vital properties can be traced to variation in size and arrangement of the graphite crystals in carbon products.



Graphite must pass good-conduct test. A tiny graphite crystal is chilled to within one degree of absolute zero, then held between poles of a powerful electromagnet while electrical conductivity is measured in each crystalline direction — one of many ways to learn more about carbon.

The sky's the limit for brush tests. This experimental chamber simulates atmospheric conditions from sea level up to stratospheric heights of ten miles or more, with controlled variations of temperatures and humidity, for development of carbon brushes to meet specific operating needs.

break-through in carbon physics research

promises future advances in carbon brushes for industry

One more barrier is down. And science strides forward in the age-old quest for deeper knowledge of carbon, one of nature's more complex puzzles.

This barrier—the inability to get large graphite crystals pure enough for experimental needs—has now been overcome by researchers of National Carbon Company. Their new annealing techniques, which remove impurities from large graphite crystals, also eliminate imperfections and weaknesses in the crystalline structure.

Several research teams at the new Parma laboratories are exploiting this break-through of science. The purified crystals are being subjected to a variety of experimental tortures—electrical, magnetic and thermal. Fundamental facts about the behavior of the single graphite crystal are being gathered and pieced together like jigsaw cutouts—building up a more complete and systematic picture. In this way, our scientists will be better able to *predict* the properties of new carbon and graphite materials.

The work on single graphite crystals is only one phase of a broad research program in carbon physics. Industrial users of carbon brushes or other carbon and graphite products, will share in the gains from this work of science at the outer boundaries of knowledge. Write for new booklet titled "Research," telling more about the work at the new Parma laboratories.

Look to **NATIONAL CARBON**
for leadership in carbon and graphite products

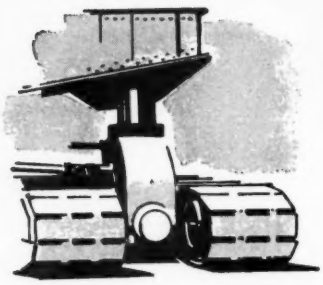
NATIONAL CARBON COMPANY • **A Division of Union Carbide and Carbon Corporation** UCC **30 East 42nd Street, New York 17, N. Y.**
Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto

How to cut mining maintenance costs

Use STANOIL Industrial Oil—save these three ways

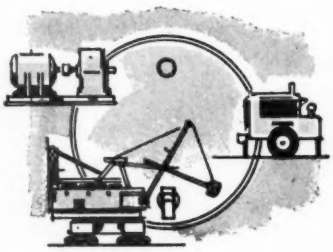
1 Reduce oil inventories

STANOIL Industrial Oil can be used in so many places that you can reduce inventories of special oils. Add to this the economy of simplified storage and handling. Use STANOIL Industrial Oil in electric motors, air compressors, fans, blowers, transmission and clutch lubrication, and hydraulic systems. Use STANOIL to lubricate bearings either in direct application or in oil circulating systems.



2 Get better lubrication

Special solvent-refining techniques plus the blending in of exclusive additives make STANOIL the finest industrial oil. STANOIL resists chemical change . . . lubricates effectively and completely over a wide temperature range . . . cuts wear. It protects oil systems from troubles due to carbon deposits, corrosion and emulsion. It stands up under heavy and repeated shock loads. STANOIL has high oxidation stability and extremely low carbon forming tendency.



3 Prevent application mistakes

When there is only one lubricant, there can't be any chance of the wrong one being used. With STANOIL, errors in application that would result in breakdowns are eliminated; equipment stays in service longer; maintenance is easier; overhauls go more smoothly and equipment is back in service faster.

Get more information about STANOIL Industrial Oil. Call your Standard Oil industrial lubrication specialist.

He is experienced in mine lubrication. There is one near you in any of the 15 Midwest and Rocky Mountain states. Or write, Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD

STANDARD OIL COMPANY
(Indiana)

Quick Facts About

STANOIL Industrial Oil

- **Stability**—STANOIL's antioxidant gives oil resistance to chemical change, minimizes deposits.
- **Rust Prevention**—The inhibitor in STANOIL "plates out" on metal surfaces, prevents corrosion.
- **Cold Starts**—STANOIL has low pour point. Flows freely from cold start. No need for costly warm-ups.
- **Resists Effects of Temperature Change**—STANOIL has high viscosity index, resists temperature change.
- **Has Excellent Demulsibility**—STANOIL is refined to eliminate emulsion problems, contains additive to minimize foaming.

DECEMBER, 1956

VOLUME 42 ● NUMBER 12

Mining

CONGRESS JOURNAL

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CONTENTS

THE AMERICAN MINING CONGRESS
RING BLDG., WASHINGTON 6, D. C.

Member
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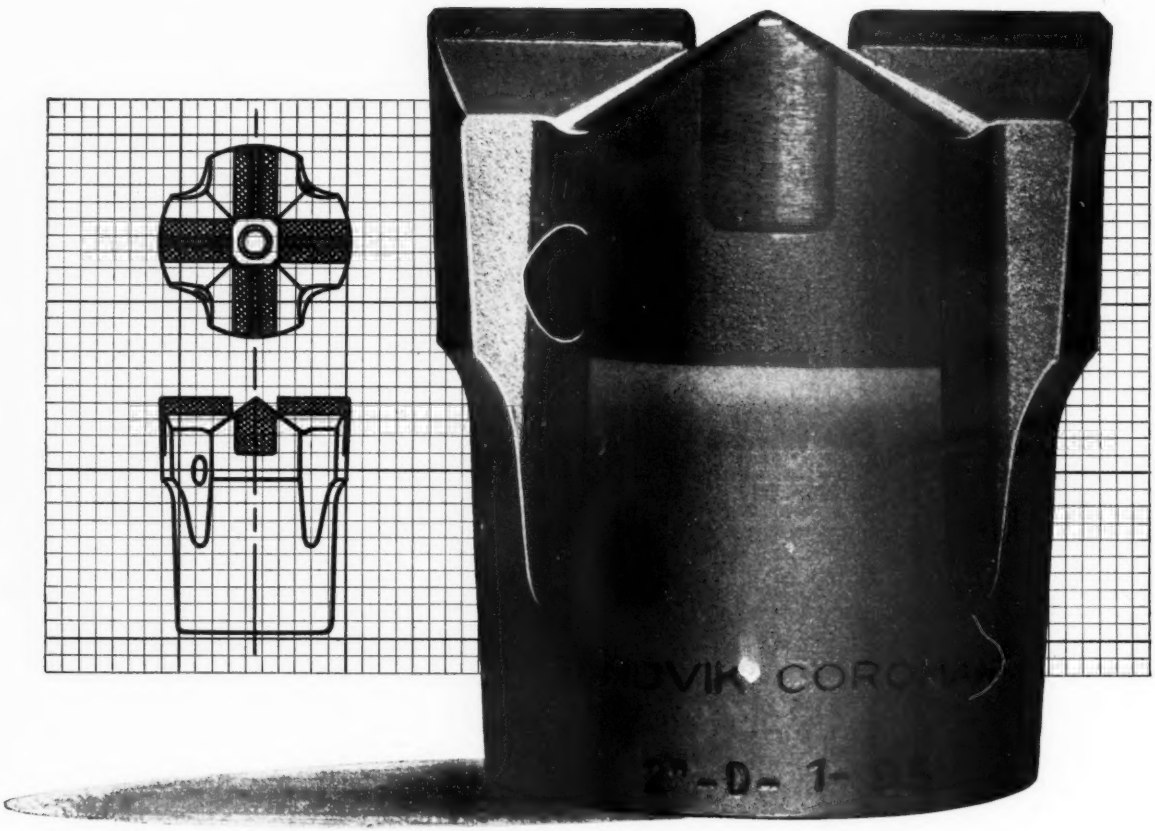
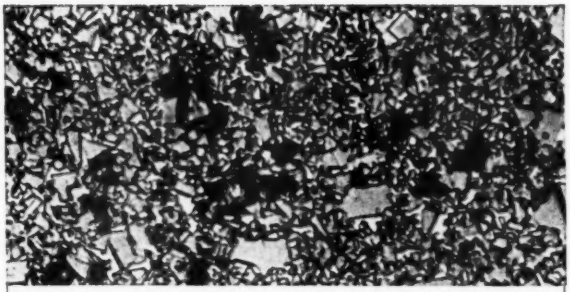
THIS ROCK BIT IS PRECISION-MADE FOR A HIGHER PERFORMANCE



Nothing tougher and more wear-resistant than the insert of a Sandvik Coromant 776 bit

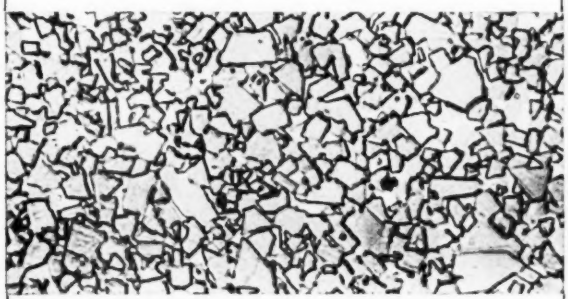
Rock bits that go on *and on* must have highest-grade tungsten-carbide inserts. Nothing but tungsten carbide in its purest state is good enough, will last as long. That's why the carbide that goes into a Sandvik Coromant 776 bit is meticulously controlled.

Sandvik, the world's largest manufacturers of brazed-in tungsten-carbide inserts for rock drilling, control every phase of production. Coromant carbide is scrutinised for impurities from the very first stages of processing the tungsten ore, right through to the final inserts. Add to that Sandvik's special process of securing the insert to the body, employing an exceptionally strong bonding metal, and you know why a Coromant 776 bit lasts longer. In 1955, one billion feet were drilled with these inserts, all fitted to Sandvik Coromant bits or integral steels. *Nothing is more conclusive of the quality of Coromant bits than this figure.*



LOW QUALITY TUNGSTEN CARBIDE

These are unretouched, 1200-times enlarged microphotos. Above, carbide full of impurities. Those black marks are contaminations which are present when production and quality control are deficient. Contamination of this kind weakens the carbide and reduces its working life.



SANDVIK COROMANT TUNGSTEN CARBIDE

This is Coromant carbide. Notice the uniformity of size and the even distribution of grain. Coromant inserts are free of dangerous porosity and impurities—the reason they go further, have greater strength.

Nothing stands the strain like the Swedish body of a Sandvik Coromant bit

When you put the strongest possible tungsten carbide into a rock bit, the body has to be the strongest available to take the extra strain. That's why Coromant bodies are made of high-quality Swedish alloy steel. But that's not all. Inserts and clearance are cylindrically-ground and the insert ends precision-tooled to exactly the same height. This means *smoother* drilling and *smoother* holes, because the load is equally distributed on all four inserts. *Precision engineering such as this give Coromant bits a longer life!*

Nothing fits like the precision-milled threads of a Sandvik Coromant bit

In order to get a smooth profile of the highest accuracy, Coromant threads are precision-milled in a special thread-milling machine and not made with a tap. Precision-milling too protects the skirt from common fatigue failures.

SANDVIK COROMANT **776** BITS

and Sandvik Coromant integral steels are available in standard sizes through Atlas Copco, who, in their own field, are the world's largest manufacturers of rock drills. Contact any of these offices *today* for further information and a demonstration.

U.S., Atlas Copco Pacific, Inc., 930 Brittan Avenue, San Carlos, California. Atlas Copco Eastern Inc., P.O. Box 2568, Paterson 25, N.J.
CANADA, Atlas Copco Canada Ltd., Montreal, Airport, P.Q.
MEXICO, Atlas Copco Mexicana S.A., Apartado Postal 56, Torreon, Coahuila.

Atlas Copco

Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment

INDUSTRIAL SCREENS

for accurate, low-cost screening

You can get a CF&I Industrial Screen that has exactly the right combination of features to assure fast, accurate, low-cost service in your screening operation. That's because CF&I Screens are available in standard and special weaves . . . and can be supplied in a wide variety of carbon and alloy steels, as well as in non-ferrous metals.

It's extremely simple to get the complete story on how CF&I Industrial Screens can be used to improve your screening operation—just contact your nearby CF&I representative. No obligation on your part, of course.

SPACE SCREENS

THE COLORADO FUEL AND IRON CORPORATION

3676

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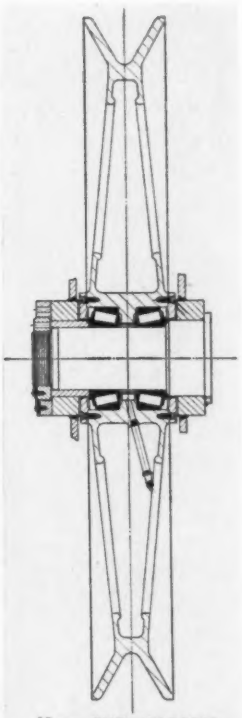


How **THE MARION POWER SHOVEL COMPANY** mounts sheaves on Timken bearings . . . to take radial, thrust loads in all combinations, keep heavy-duty sheaves in positive alignment.

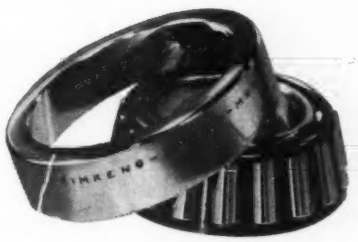
World's largest shovel scoops 90 tons, lifts it 10 stories moves it 290 feet on 34 TIMKEN® bearings

BUILT by the Marion Power Shovel Company, this gigantic "coal miner" moves many tons of overburden per hour for the Hanna Coal Company. With 10 motors controlling the digging cycle of the 90-ton capacity dipper—an additional 4 motors for its 8 powerful cat treads—built-in elevator—auxiliary crane for hoisting equipment aboard—this tremendous earth mover is 100 times larger than the ordinary construction shovel.

34 Timken® tapered roller bearings carry terrific radial and thrust loads in all combinations, at critical points—including swing machinery and all hoist sheaves. Full line contact between rollers and races gives extra load-carrying capacity. And because Timken bearings have case-carburized rollers and races—shock-resistant cores under hard, wear-resistant surfaces—they take heavy shock loads. Designed to roll true, precision manufactured to live up to their design, Timken bearings practically eliminate friction, reduce wear on integral parts. Closures are more effective, too, because Timken bearings keep housings and shafts concentric, keeping lubricant in, dirt, dust, water out.

When you buy or build machinery, look for the "TIMKEN" trade-mark on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



TIMKEN TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD

You Get "Pay-Off" Performance Every Day with Le Roi-Cleveland Sinkers

...because they have the right force of blow and strong rotation, from proper valve design and port arrangement

That's why Le Roi-Cleveland Sinkers bite into more rock . . . drill more footage per shift. A fast, postive-action end-seating valve, and precise port arrangement, provide powerful force of blow and strong rotation. And this automatic valve meters the air, too. It keeps air consumption down. You get longer life because the performance of this valve is not affected by wear.

Le Roi-Cleveland Sinkers are lubrication-protected. The rifle bar is oiled at every stroke of the piston. This prolongs rifle nut life by 50 per cent or more. That's one of the reasons why you get "pay-off" performance every day in all conditions. Le Roi-Cleveland Sinkers are at their best when the going is toughest.

There's plenty of hole-cleaning power to aid the powerful force of blow and strong rotation of Le Roi-Cleveland Sinkers. They take a fresh bite of rock with every piston blow.

"Pay-Off" performance is really built into all Le Roi-Cleveland Sinkers. Use them to get peak efficiency every day . . . drill more feet of hole per shift. A complete line of Le Roi-Cleveland Sinkers is available from 18 to 80 lbs. Write today for full information.

RD-77

LE ROI *Division of Westinghouse Air Brake Co.*
Milwaukee 1, Wisconsin


PORTABLE AIR COMPRESSORS


TRACTAIR


STATIONARY AIR COMPRESSORS


AIR TOOLS


ENGINES

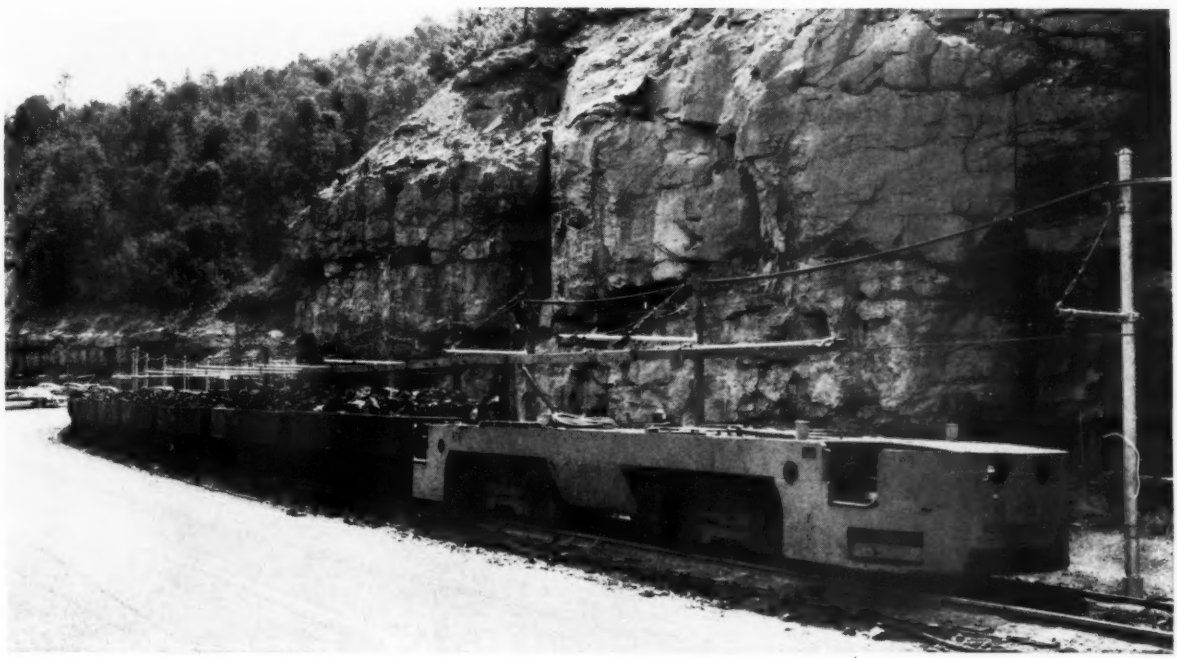
For heavy hauling you'll do better with **JEFFREY** 8-wheel Trolley Locomotives

Big coal loads can be hauled fast with Jeffrey 27, 37 or 50-ton single-unit locomotives.

Operation and maintenance are better, too. The four-wheel, equalized double trucks and the short overhang at the ends give an easy ride at high speed. The eight wheels distribute the locomotive's weight for less concentrated rail loading.

Outstanding operating and safety features include: roller-bearing type journal boxes and motor axle suspensions . . . air and dynamic service brakes . . . automatic couplers with air-operated uncoupling . . . trolley with air-operated retriever . . . separate blower for each motor.

Other features of 8-wheel locomotives and other types for mainline and secondary haulage are described in Catalog 836. For a copy, write to The Jeffrey Manufacturing Company, Columbus 16, Ohio.



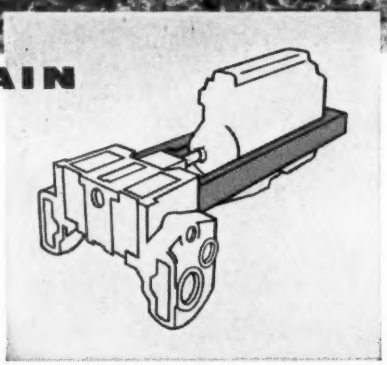
JEFFREY

MINING • CONVEYING • PROCESSING EQUIPMENT
TRANSMISSION MACHINERY • CONTRACT MANUFACTURING

ALLIS-CHALMERS HD-21

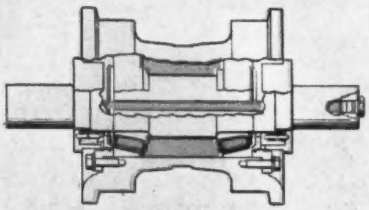
Engineered to take the Strain, the Shock, and the Grind of Modern Mining Methods

THE STRAIN



You encounter frame-twisting stress as you punch haul roads through rough, rocky terrain. Jobs like this prove the value of Allis-Chalmers exclusive all-steel, box-A main frame. It is strong and flexible . . . soaks up vertical, horizontal and torsional strains. It is a complete unit . . . does *not* use the engine as a structural member. In addition, it allows more efficient equipment mounting, provides excellent weight distribution and makes possible unit construction for unmatched servicing ease.

A crawler tractor must handle many different jobs in a mining operation . . . and every job tests its durability in a different way. Let's see how Allis-Chalmers engineers have anticipated these demanding conditions . . . and have designed the HD-21 to meet them.



THE GRIND

These tracks churn all day in fine, abrasive stone . . . could be a serious threat to final drive, idler, truck wheel and support roller bearings. But this "grinding compound" never reaches the bearings on an Allis-Chalmers tractor. Exclusive design features make it possible to use tapered roller bearings with *positive* seals that keep dirt and moisture out and hold lubrication in for at least 1,000 hours without lubricating attention.

THE SHOCK

Sudden overloads are common in dozer operations around a mine. But hydraulic torque converter drive cushions the shock and protects the entire power train. This drive is standard equipment on the HD-21 and has been *proved* on Allis-Chalmers tractors since 1940.

HD-21

Approx. Weight (as illustrated)
with hydraulic bulldozer 51,265 lb
with cable bulldozer 52,650 lb
204 net engine hp

Ask your Allis-Chalmers Construction Machinery dealer to show you the many other ways the HD-21 has been designed with your tough problems in mind.

ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

"AIRDOX

NON-EXPLOSIVE MINING METHOD

Helps Us Market Good Coal"

SAHARA COAL FOR SALE HERE
THE SIGN OF GOOD COAL

says **HENRY C. WOODS**
Vice-President
Sahara Coal Company, Inc.

"To back up our company creed, 'The Sign of Good Coal,' we must mine quality coal and deliver it in the size ordered. AIRDOX assures this by *producing unshattered coal* in the mine . . . *reducing degradation* in transit. In other words—AIRDOX helps us market good coal by minimizing disintegration.

"It is also the best method for us because it produces less fines, reduces cleaning costs and makes loading easier, faster. No other method gives us these cost-cutting advantages . . . plus the uniform quality coal demanded by users today! We were one of the first to use AIRDOX in southern Illinois and have used it consistently ever since."

AIRDOX

NON-EXPLOSIVE MINING METHOD

Cuts Costs 5 Ways

- Produces less fines in face preparation
- Rolls coal forward for faster, easier loading
- Easier on "tender" roofs—cuts timbering, bolting
- Lowers cleaning costs by minimizing fines
- Reduces degradation—no shattered coal

GET ALL THE FACTS—WRITE FOR FREE SURVEY

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Only JOY Tungsten Carbide ROCK BITS offer all these features

The results of improved manufacturing techniques

OFFSET DESIGN OF WINGS for drag-free rotation, faster removal of cuttings to permit faster drilling, easy and inexpensive reconditioning.

DEEP SLOTTED CHIP-WAYS allow cuttings to escape readily; the bit does not regrind its own cuttings.

IMPROVED TECHNIQUE FOR BRAZING INSERTS to prevent loss of inserts and to assure maximum drill footage and minimum loss of gauge.

MACHINED FROM SPECIAL ALLOY STEEL and heat treated by an exclusive process to provide high fatigue life and maximum shock resistance. This feature makes the Joy Tungsten Carbide Bit *best for any rock formation.*

CHOICE OF TWO GRADES OF TUNGSTEN CARBIDE—a hard grade for abrasive formations and a medium grade for harder formations.

PRECISION MILLED THREADS insure dimensional uniformity, positive rotation and uniform thread tolerances.

CONCENTRIC PRECISION MILLED SEATING SURFACE permits full contact of bit threads and rod threads. The bit seats firmly against the drill rod upset, radial play is prevented and life of threads and rods is lengthened.

Joy Tungsten Carbide Rock Bits are available in the following gauge sizes:

CROSS TYPE, JHO—1⅛", 1⅝", 1¾", 1⅞", 2"
CROSS TYPE, JDO—1⅞", 2", 2⅛", 2¼", 2⅜", 2½", 2¾", 3"
X TYPE, JX—3½", 4", 4½"

● *Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.* In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Write for FREE Bulletin 70-3

Consult a Joy Engineer

for AIR COMPRESSORS, ROCK DRILLS, CORE DRILLS, HOISTS and SLUSHERS, MINE FANS AND BLOWERS

WSW M6012-70

JOY

WORLD'S LARGEST MANUFACTURER OF UNDERGROUND MINING EQUIPMENT

In cramped quarters like this, Tournapull Rear-Dump turns in dump position, which moves rear wheels forward for extremely short wheel-base. With bowl raised, 22-ton capacity C Tournapull, shown, turns 180° in only 20' 8" wide area, without backing.

Short 180° turns

boost pit output, cut handling costs

If you are interested in cutting cycle time on your off-road hauls, consider Tournapull Rear-Dumps.

These high-production units are extremely maneuverable, can back into a shovel or restricted dump area faster than any haulers on the market. They make 180° turns by power steer thru geared king-pin in less than their own length. They eliminate time normally wasted maneuvering back and forth to turn in narrow quarters. They also frequently eliminate expense involved in construction of skid-plates or special turn-around areas.

Even where space is unlimited, rig's 90° prime-mover-turn gives you faster cycles. At the shovel, fast-maneuvering Tournapull Rear-Dump swings in and positions in 1 quick move. Loading unit need not sit idle while hauler operator wastes time on a wide sweeping turn, and a long, slow back-in. Quick, safe spotting saves additional production time at fill.

Simplicity reduces maintenance

A great deal of your usual maintenance expense is also eliminated because of the simplicity of Tournapull's turn mechanism. Steering involves only an electric motor, connected to a rugged ring gear king-pin shaft. A flick of operator's finger activates motor . . . causes prime-mover to pivot up to 90° around trailing unit. Turns are made quickly, regardless of footing. There are no front steering knuckles, no reach rods, no complicated mechanisms to get out of line, maintain, or repair.

Check these, and all the other advantages of Tournapull Rear-Dumps. See for yourself how they speed haul cycles and cut costs. Write or call, any time, for owner-verified production studies and specifications. There's no obligation.

Model	Capacity	HP	Overall Length	Width req'd. for 180° turn	
				Travel position	Dump position
D	11 tons	138	24'10"	24'8"	18'8"
C	22 tons	208	29'9"	28'8"	20'8"
B	35 tons	293	35'10"	35'	27'

These features, too, cut your hauling costs

Hauls anywhere—Travels safely over narrow haul roads, paved highways, city streets. . . hauls cross-country over terrain, thru muck, rock, and soft fill.

Dumps fast, clean — Electric motor lifts body quickly to any desired dump angle . . . bowl tips behind rear wheels for clean over-bank spill. Streamlined body sheds material readily.

Cuts weather delays — Power-transfer differential applies extra power to wheel on firmest footing . . . pulls rig through mud, sand, soft materials.

Rugged body loads easily — Big bowl opening is easy loading target. Three layer, *all-steel* bowl with tool-steel floor resists wear and shock. Available with optional tailgate.

Improves safety — More than 4 times the braking surface of ordinary haulers plus optional electrotarder, low center of gravity, excellent visibility, front-wheel drive, easy control, all contribute to maximum safety.

Reduces fatigue — Big tires and air-foam cushioned seat smooth out ride for operator. Electric power steer and 2-way power dump make work easy.

Insures future earnings — Behind basic prime-mover you can interchange other trail units: scraper, bottom-dump, lift-and-carry crane, logging-arch, flat-bed hauler. Keeps your Tournapull busy at a profit all year-around.

Tournapull—Trademark Reg. U.S. Pat. Off. R-1168-M-b

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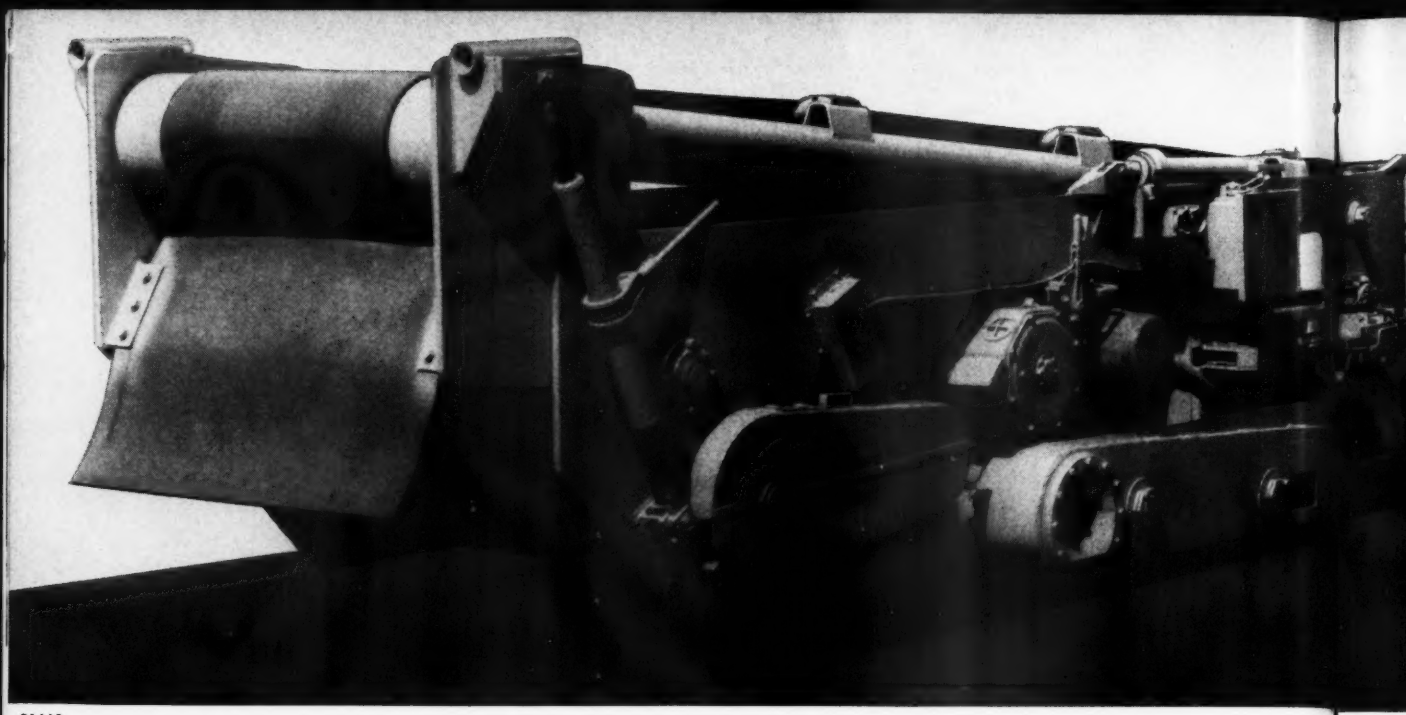
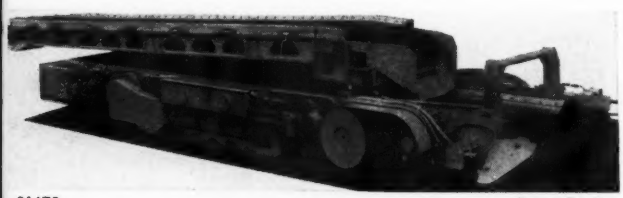


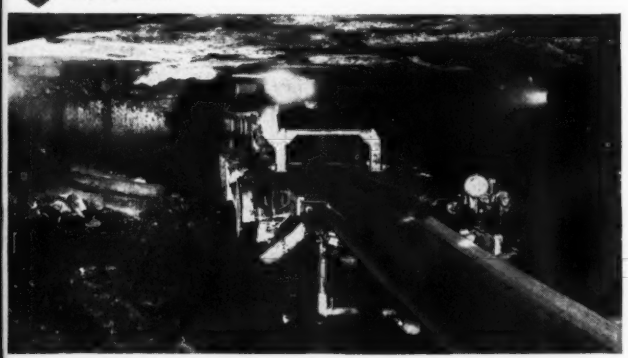
21668

The NEW Goodman ROPEX®



21678 Patents Pending

Bridge conveyor between tread mounted tail section and continuous miner swivels to right or left, has 13½-foot range of forward and back travel. Hydraulic driven drums on tail section store wire ropes that support carrying idlers.



● Ropex is an extensible belt conveyor equipped with tread-mounted, motor-driven head and tail sections. The head section carries an ingenious arrangement of spools for belt storage. The tail section is equipped with winding drums for wire rope storage.

● Ropex is available for 48" and 72" seams and can be extended up to 1000 feet in length. Predetermined tension on both belt and wire ropes is automatically maintained during extension or retraction, loaded or unloaded.

● Ropex has no fixed structural framing . . . no rigid idler assemblies. Instead, parallel wire ropes carry chain-linked idlers over which the belt travels.

● Ropex is flexible . . . resilient. The wire ropes and hinged idlers "give" in accordance with the weight carried. The load rides smoothly, evenly, with nothing to cause shifting or spilling. At the same time, impact shock on bearings and belt is reduced to a minimum.

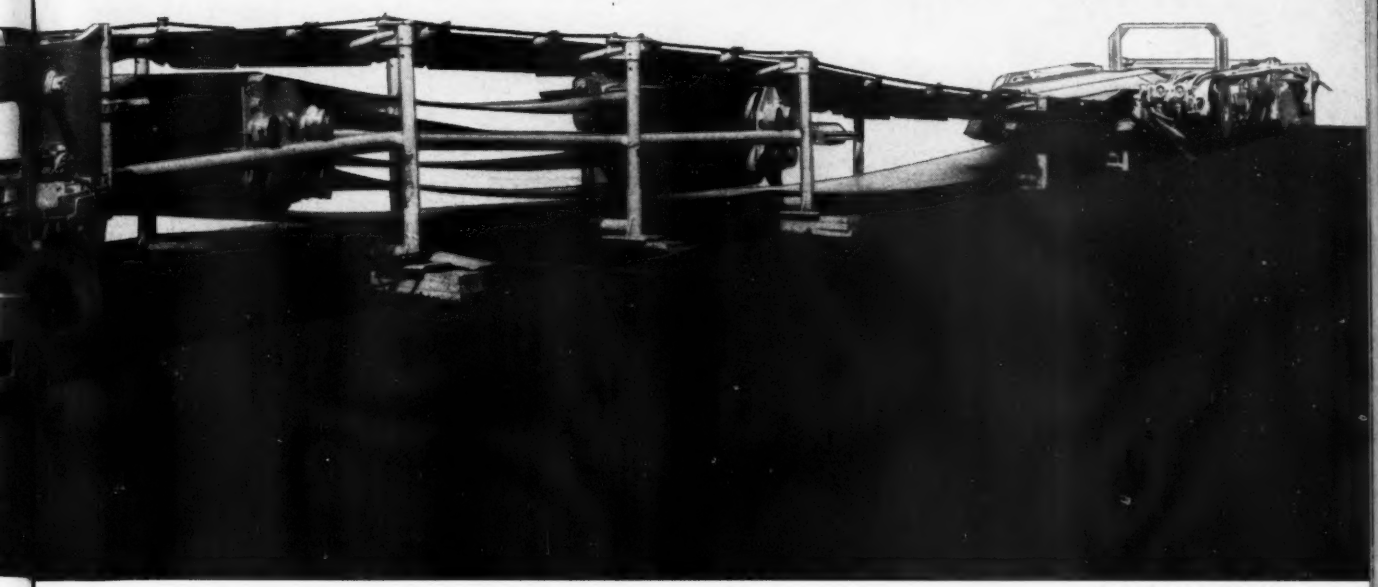
NOTE THESE GOODMAN "FIRSTS"

- Goodman was first with the Rope Belt Conveyor, now widely used in coal and ore mines. Ropex is a development of this idea with the added feature of extensibility.
- Ropex is the first 36" width extensible belt conveyor in operation.
- Ropex is the first extensible belt conveyor with the capacity to handle the output of a Goodman Continuous Borer (8 to 10 tons per minute) or any other continuous mining machine.
- Ropex is the first extensible belt conveyor to provide for as much as 200 feet of belt storage in the head section for 100-foot extension without interruption to the continuous flow of coal.
- Ropex is the first extensible belt conveyor with open type belt storage.
- Ropex is the first extensible belt conveyor with adjustable height discharge.

With Ropex there is no rigid assembly along the belt line. Parts are few, lightweight, easy to handle and store. Labor for moving, installing and extending is reduced.

Patents Pending

Belt to permit extension of Ropex is stored in framework attached to tread mounted head section. Open construction eases task of adding belt, permits ready inspection, provides rub-free belt travel. Provisions available for storage of as much as 200 feet of belt. Spools that carry belt store compactly in head section when unit is moved.



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Extensible Belt Conveyor

moves coal from the face as fast as it can be mined by any Continuous Miner

Here is a fast, high capacity conveyor that actually extends itself . . . increases its own length . . . under its own power. It advances as the Continuous Miner advances . . . keeps pace with the face . . . eliminates delays and interruptions . . . provides a continuous flow of coal back to the out-of-mine transportation system.

The Goodman Ropex Conveyor is linked to a continuous mining machine by means of an independent motor driven bridge conveyor with a 13½-foot range of travel. As the mining machine advances to the limit of this range, the tail section of the Ropex Conveyor is trammed forward. Belting and wire rope pay-off automatically. Supporting stands and idler assemblies are added along the line as needed. Meanwhile the mining machine keeps right on cutting. The flow of coal need not stop for a moment during a full 100-foot advance. At that point a new section of belting is easily added and continuous operation is resumed.

The efficiency and smooth, continuous operation of the Goodman Ropex Conveyor have been thoroughly tested and proved. Now this most modern of all mining equipment is ready to serve you. Let us give you the story in full detail. Write, wire or phone today.

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you benefit by:	. . . and avoid:
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• CONTINUOUS HIGH-LEVEL EFFICIENCY Low initial cost permits battery replacement as needed assuring continued new lamp performance	The penalty of dwindling efficiency and poor performance just to obtain long life
• TRUE AUTOMATIC CONSTANT-POTENTIAL CHARGING Charging is regulated automatically without manual attention on the part of the lampman	Costly manual attendance and variable charging
• MINIMUM MAINTENANCE Weekly watering, bulb replacement and ordinary cleanliness	Having covers to open, valves to free, terminals to clean, lamps to rack, cells to recondition
• LEAK-PROOF BATTERIES Regardless of position, electrolyte cannot escape	Burns from electrolyte
• LARGE BATTERY CAPACITY Yet small compact battery weighs only 64 ounces	Cumbersome battery size and excessive weight

the trend is to WHEAT!

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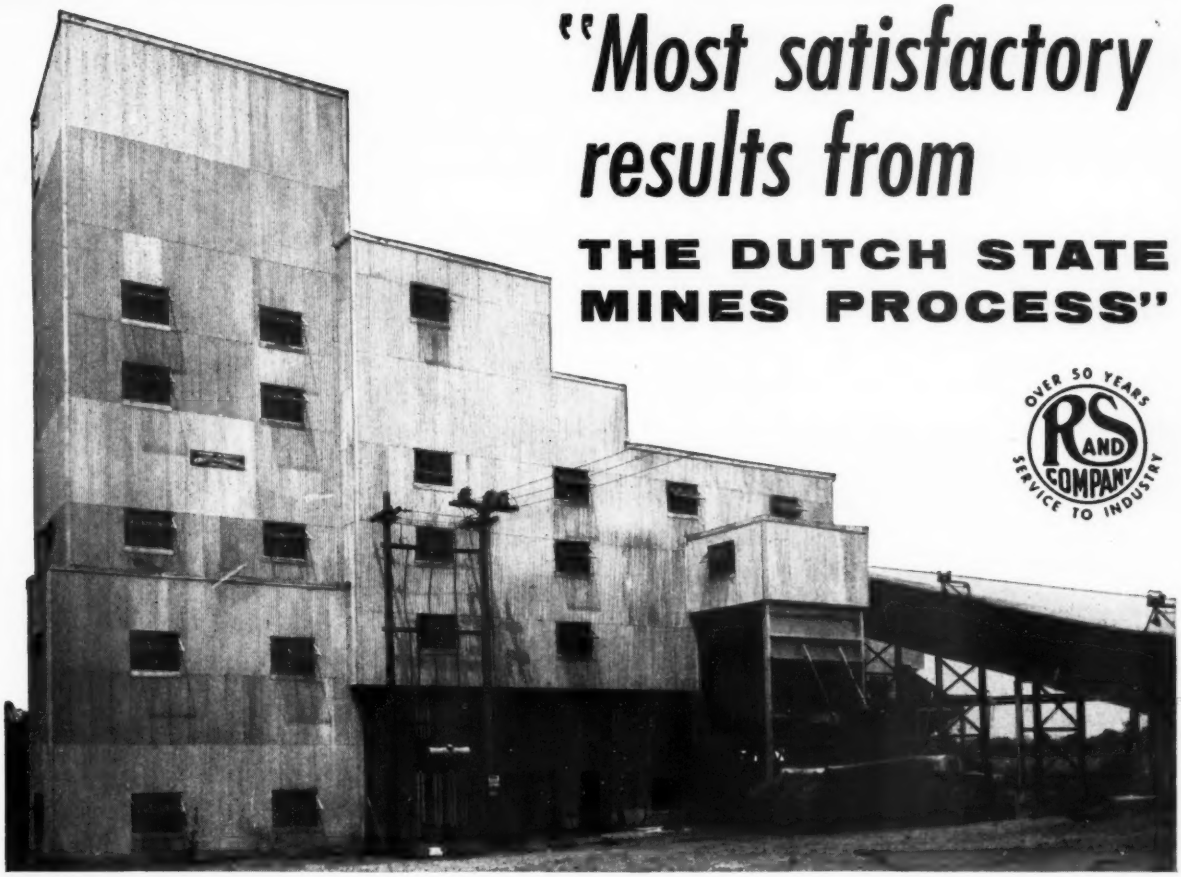
"Most satisfactory results from THE DUTCH STATE MINES PROCESS"



Dutch State Mines heavy medium process showing the static pool vessel and flights removing pure coal.

Pure coal after the final rinse.

says Frank Nugent, Executive Vice President, Freeman Coal Mining Corporation, speaking of his experience with the Dutch State Mines heavy medium separation process installed by Roberts & Schaefer in Freeman Mine No. 4 Williamson County, Illinois.

Freeman had approached R & S engineers with the problem of obtaining high quality coal from their new mine operating in the quality circle in Southern Illinois. This was the perfect application for the recently acquired Dutch State Mines process. With more than 50 years of coal preparation plant experience, including the designing and building of the most modern washing equipment for normal coal preparation, Roberts & Schaefer had realized that the trends required more precise cleaning. They had, therefore, secured the franchise to market the Dutch State Mines process in the United States. R & S were ready. Freeman needed the best coal washing equipment in the world—and they got it!

The plant has now been in operation for over six months and has thoroughly proved its efficiency; in fact, results are far better than were originally thought possible. As a result, Freeman is producing quality coal for quality customers.

Do you have a washing problem that is unusually severe? Possibly the Dutch State Mines process is what you need to solve it. Phone, wire or write for consultation.

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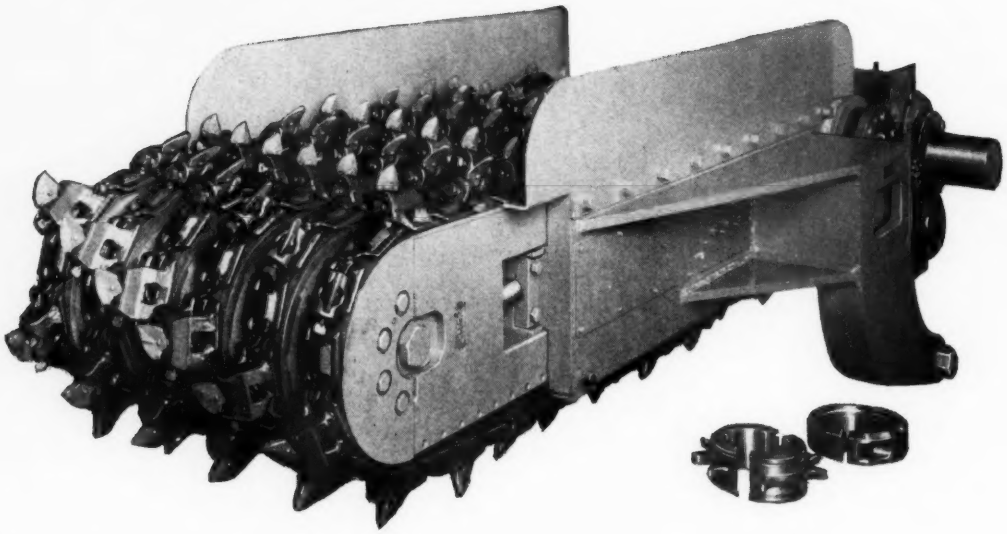


presenting another advance in modern mining . . .

6-IN-ROW RIPPER HEAD

. . incorporating Bowdil Carbide Bits

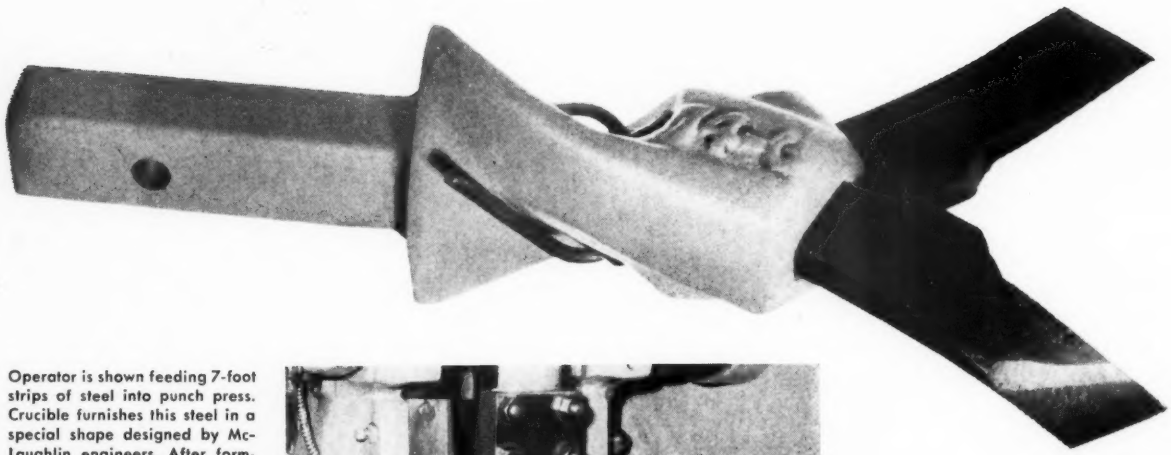
POINTS OF ADVANTAGE:

1. The Bowdil Fabri-Forged Chains, with their great strength and flexibility. The strongest chain for its size in the field.
2. The Bowdil Ripper Head utilizes 6 renewable, independently adjusted Cutterbars, making it possible to retain equal tension on all 6 chains regardless of their length or age, within liberal limits.
3. Special hard-surfaced wearing shoes in heads of Cutterbars eliminating maintenance on roller and bearings as formerly used.
4. All 6 chains are similar in kerf and lacing arrangement for interchangeability.
5. The chains may be run with or without renewable liners in the Cutterbars as desired.
6. Included in the Ripper Head assembly is a special improved design head drive shaft and sprocket assembly, which makes it possible to renew a sprocket in minutes without removing the shaft—(two-piece sprockets are used, held on the double keyed shaft by means of special designed resilient clamping collars, maintaining extreme tension to the shaft).
7. All 6 sprockets are interchangeable.
8. The rear of the Ripper Head frame is arranged with circular shock seats for the drive assembly which normally clears the drive assembly approximately 1/16" to guard against extreme flexing of the drive shaft at overloads. This avoids breaking the shaft.
9. The Ripper Head is complete—nothing else needed from the gear boxes out.

Manufactured by **The BOWDIL Company**

CANTON 3, OHIO

Bits of Crucible Silicon-Manganese alloy steel shown in holder. They are produced by McLaughlin Manufacturing Co., Inc., Joliet, Illinois.



Operator is shown feeding 7-foot strips of steel into punch press. Crucible furnishes this steel in a special shape designed by McLaughlin engineers. After forming to finished size, the bits are heat treated and the point and cutting edge are sharpened by hand.

special CRUCIBLE alloy steel

gives bits maximum impact and abrasion resistance . . .

Cutting through abrasive materials like coal, soft limestone and shale demands a *special* steel. A steel that's hard without being brittle – that will take and *hold* a keen edge.

That's why Crucible produces a *special* Silicon-Manganese type alloy steel for the McLaughlin Manufacturing Co., Inc., manufacturers of these bits. It's a steel designed for optimum shock and abrasion resistance.

After McLaughlin tested Crucible's special alloy in the coal fields, their verdict was "This Silicon-Manganese steel is the finest alloy steel available."

Crucible will be glad to produce a *special* steel to meet your particular needs, too. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Editorials

ROBERT W. VAN EVERA, *Editor*

DECEMBER, 1956

National Minerals Policy

HON. FRED A. SEATON, Secretary of the Interior, reviewed the present administration's mineral policies in his talk before the opening session of the American Mining Congress in Los Angeles last October. When the 85th Congress convenes next month, it will do well to consider the administration's program in the light of the basic importance of mining in our economy and its vital role in national security.

Three general areas that require attention were cited by Seaton: "improved and extended research and technology; the creation of a more favorable business climate that will encourage investment and the plowing back of earnings; and a mutually profitable foreign trade policy."

While not in agreement with the prophets of doom who shout that the United States is soon to become a "have not" nation, Seaton believes we should let their warnings alert us to action that will avert the catastrophes they predict. Commending the industry for its sound understanding of the long range problems, Seaton said, "A new era may well be on its way. The Eisenhower Administration, I promise you, will make every effort to encourage this movement and to create a favorable environment for industry to make large investments of risk capital in the vital search for new mineral wealth."

He added that, "We must put increased emphasis on finding profitable ways to use the mineral supplies we have in abundance rather than exhaust all our energy in trying to expand output of those supplies which are very scarce."

Seaton pledged himself as Secretary of the Interior to help maintain within this country a sound and vigorous mining industry. The first step in projecting a long-range program, he said, is to intensify and expand the present program of geologic and topographic mapping, basic research, studies in the improvement of mining and beneficiation, and research in the development of new products.

"As a second step," he continued, "we must make sure that the new technology developed from research is made available to the mining industry."

"As a third step, we need to re-examine the impact upon the mining industries of the tax laws and other Government fiscal measures. Changes made in Federal taxation in 1954 have been helpful." Seaton heartily endorsed recommendations by a Cabinet Committee on Small Business for "further modifications of the tax laws which would enable small business to plow back a greater part of its earnings. These recommendations, if enacted into law, would be of real benefit to the large number of small mining operations."

"Finally, in projecting a long-term minerals program," he said, "we have to look carefully at our foreign trade. We are now studying the impact of imports upon the domestic production of those minerals and metals which are critical to defense. A special subcommittee of the House Ways and Means Committee is taking a careful look at our trade policies. The Department of Interior expects to take advantage of this study."

Both the nation and the mining industry—metals, coal, and industrial minerals—have much at stake in the program set forth by the Secretary—and we eagerly watch for legislative action on these problems which will enable the mining industry to do its part in maintaining our national safety and well-being.

Rotary Drilling For Open Pit Blast Holes

Operators have found good application for rotary drills in the Lake Superior ranges as a result of comprehensive tests under rugged drilling conditions. Here is a detailed report on tests made with rotary units to determine their feasibility for drilling Mesabi Range iron ores.

By R. W. WHITNEY
Manager of Mines
The M. A. Hanna Co.

A rotary drill being set up at a Mesabi Range iron ore mine. Proven in oil well drilling and successful in the coal fields, rotary drilling on the Mesabi Range is here to stay

FOR as many years as most of us have been engaged in the mining industry, the drilling of blast holes has depended almost entirely upon percussion type and churn or "cyclone" type of drill. On the Mesabi Range, where the open pit mine is preponderant, a tremendous footage of blast hole has been drilled with these drills, especially the "churn drill." Considering the material in which they were used and the conditions under which they operated, these drills did a fairly efficient and commendable job. Notwithstanding the introduction of more modern drilling machines and methods, there remains certain applications for the percussion and churn type drills that will insure them of being around for a long time.

During the past ten years however, there were many indications that a more economical drilling method was required on the Mesabi Range. The ratio of cu yd of taconite stripping per ton of iron ore was increasing rapidly; labor and supply costs were steadily rising and the element of drilling time began to enter the picture. It was apparent that the old method of raising the drill

bar and letting it fall was too slow and expensive for tomorrow's production and cost requirements. It was time to try other methods of rock drilling.

Rotary Used in Coal Fields

Having previously experimented with various models and types of drills, it was decided to see what the rotary drills had to offer. They have been in use in one form or another for many years, especially in the oil fields. More recently the modern mobile type of rotary drill was developed, and has been successful in the coal fields—so successful in fact, that the cyclone or churn types have been virtually retired from service.

The initial testwork was conducted during the summer of 1952 near Cadiz, Ohio, where the Pittsburgh Consolidation Coal Co. had a Joy 58-BH rotary drill available for this work. Various rotary bits were tested in large slabs of taconite shipped in for this purpose, in an attempt to determine what performance and operating costs could be expected.

The results of these tests confirmed the original assumptions: (1) That there was a possible application for rotary drilling in taconite, and (2) that something better than the standard steel rotary bit would have to be developed to withstand extremely rough service in taconite. In other words, it was not as necessary to test the machine as it was to test the rotary bit.

At this point it may be well to explain the term "Taconite" as used here. It is a general term applied to the highly silicious lean iron formation which occurs in layers of varying thickness and hardness and is usually fractured and blocky in varying degree. It is not to be confused with the so-called "East End Taconites" that are more massive and homogenous. Drilling in the latter taconite is a subject in itself.

Tricone Bit Improved

The initial testwork on the Mesabi Range was started in April of 1953, using a Joy 58-BH rotary drill and Hughes Tricone rotary bits of 6¾-in. and 8¾-in. diameter. Both the standard steel bit and specially constructed tungsten carbide insert bits were used in the first drill hole. From that point on, all efforts were directed exclusively to the development of the tungsten carbide bit. Shortly after the start of the tests, the 6¾-in. tungsten carbide bit was also dropped from the program as it was evident that larger diameters were required to provide more wear surface and bearing support.

With the production of each new and improved 8¾-in. tungsten carbide bit, the Hughes Tool Company showed remarkable results in extending bit life and reducing the bit cost per ft drilled.

The bit cost per ft attained with the first tungsten carbide bit was roughly three times that of a conventional 42-T Churn Drill with a 9-in. bit. After the first modification the bit cost was approximately twice that of the 42-T drill. The final modification of the 8¾-in. bit resulted in the bit cost per ft being slightly under the 42-T cost.

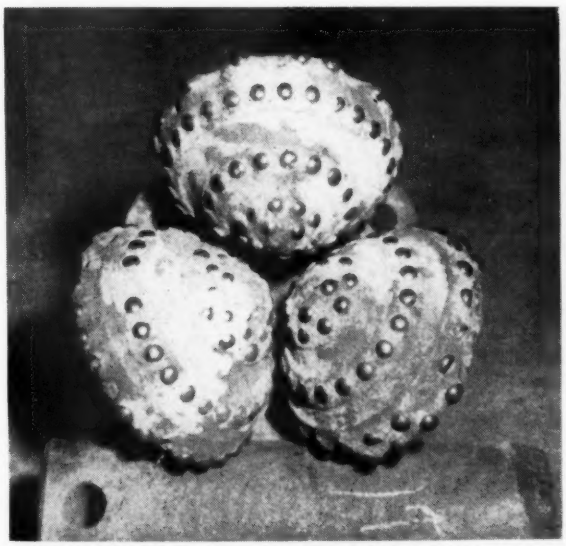
Although some progress was made, the reduction in the final cost per ft of the 8¾-in. bit was less than had been hoped for, but the penetration rate of the rotary drill was 2 to 2½ times that of the 42-T. This testwork then led to the following conclusions:

1. Rotary drilling definitely had a place on the Mesabi Range.
2. Larger bit sizes, perhaps to the 12-in. diameter, held promise for better bit life.
3. It would be necessary to change from the Joy 58-BH, which at that time had capacity up to the 8¾-in. bit, to a Bucyrus-Erie 50-R, designed to accommodate bits up to 12¼-in. diameter.

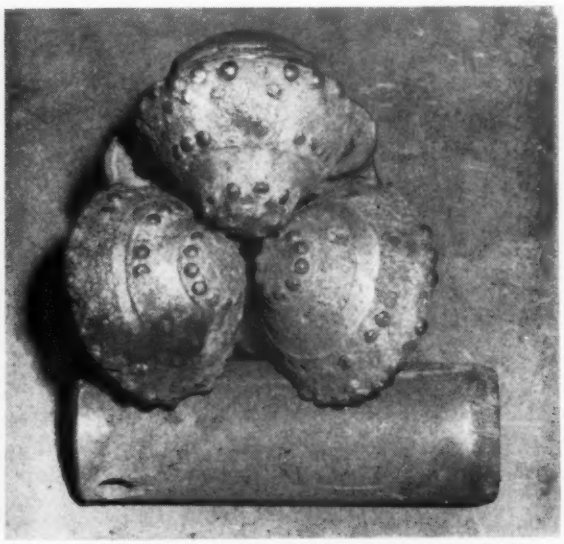
Accordingly, the experimental work was resumed in February 1955, using a Bucyrus-Erie 50-R rotary drill. In addition to continuing the develop-

About the Author

RICHARD W. WHITNEY has been identified with iron mining since 1920 and is at present general manager of mines for the M. A. Hanna Co. From engineering to operations, he has followed the latest advances in Mesabi range mining practice, and is well-qualified to describe rotary drilling for open pit blast holes.



Type RG-2J, 9⅞-in., rotary bit—Actual drilling time was 16 hours 36 minutes and the footage drilled, 592. Remaining bit life is 30 percent



Actual drilling time of this 10⅝-in. rotary bit, type RG-2J, was 34 hours 35 minutes. During this time it drilled a total of 510 ft of hole

ment of the rotary bit itself, the work was now expanded to include a study of bit diameters in relation to drilling and blasting costs. For the latter purpose, three diameters—9⅞-in., 10⅝-in. and 12¼-in. sizes were used. More will be said about this later.

Penetration Rate Tripled

Throughout 1955, test drilling was carried on in taconite, banded rocky lean ores, and in the softer rocky wash ores. A total of 112,250 ft of blast hole was drilled, of which approximately 50 per cent was in hard or medium hard taconite. The following table indicates the experience to date in different materials:

Type of Material	Ft Drilled	No. of Bits	Average Bit Life	Penetration Rate ft per hr
Wash Ore & Tac. Seams	31,100	14	2,220 ft	47
Taconite—Very Hard	35,400	36	983	23
Medium to Hard	24,900	12	2,075	40
Lean Ore & Hard Tac. Seams	14,650	11	1,330	35
Frozen Paint Rock	6,200	1	6,200	70
TOTAL	112,250	74	1,516 ft	38

The bit with the shortest life was a 10⅝-in. bit that was worn out after 890 ft of drilling in extremely hard taconite. The best bit life experienced to date (aside from one bit used to drill frozen paint rock) was 3,390 ft, obtained with a 9⅞-in. bit in wash ore and heavy taconite seams.

In general, the rate of penetration in taconite was 3½ to 4 times that of the 42-T using a nine-in. bit, and the over-all cost averaged 20 per cent less than the 42-T cost.

In the softer rocky wash ores, the penetration rate of the rotary drill was also four times that of the 42-T, but the cost reduction rose to 30 per cent.

Drilling in the harder banded lean ores presented a picture that may or may not be indicative of the following figures, as this particular test compares 6,000 ft of rotary drilling against 600 ft of 42-T churn drilling. In any case, the penetration rate of the rotary drill dropped to only two times that of the churn drill, while the over-all cost of the rotary drill was slightly greater than the 42-T costs. Reasons that have been advanced for this are:

1. The 42-T did not drill enough hole to determine the correct cost.
2. The frequency of breaking from a hard seam into a much softer seam in the lean formation caused undue wear on the rotary bit.

Additional testwork in similar material will have to be done to determine the answer to this.

In general and for comparison's sake, it may be said that the over-all average penetration rate of the rotary drill is approximately three times that of the 42-T drill, while the over-all reduction in drilling cost is between 20 and 25 per cent.

Bit Sizes Studied

The relative performance of the various size of Tricone bits is also of interest. In one test area, 10,000 ft of hole were drilled in medium-hard and uniform taconite under exacting supervision and as nearly identical conditions as possible. Drilling against a 42-T churn drill, the rotary drill tested the 9⅞-in., 10⅝-in. and 12¼-in. tricone bits. For all bit sizes, the rotary drill costs ranged from a 10 per cent cost reduction to a 34 per cent cost reduction as compared to the 42-T costs. The penetration rate was slightly over four to one in favor of the rotary drill.

The results of this test indicated that the 10⅝-in. diameter bit produced the lowest-cost drilling, while the 12¼-in. bit ran consistently 10-15 per cent higher than the 9⅞-in. bit. Subsequent drilling with both the 9⅞-in. bit and the 10⅝-in. bit has not borne out the indicated superiority of the 10⅝-in. bit over the 9⅞-in. bit. In certain formation, one size of bit drills more economically than the other, and vice versa. It is noted here that many of whys and wherefores of rotary drill bits are still undetermined. We are convinced for the time being, however, that the 12¼-in. bit is not too well suited for the type of material and operation encountered on the Mesabi Range.

In recent months, some drilling was done in softer wash ores using the W7R steel tricone bits. Because of the greatly reduced initial cost of the standard steel bits, the bit cost per ft drilled was fairly good—being approximately 50 to 80 per cent of the bit cost per foot using the tungsten carbide bit. However, the application of the steel bit is so limited that whatever savings are made on the bit cost are lost through delays resulting from changing to tungsten carbide bits when hard seams are encountered.

The size of the rotary bit apparently has little to do with the rate of penetration, as the three sizes used in the testwork had almost identical rates, approximately 38 ft per hour; the penetration rate evidently being a function of the downpressure on the bit. All bits used had a feed pressure of 5,000 lb per in. of bit diameter; 49,000 lb on the 9⅞-in. bit, 54,000 lb on the 10⅝-in. bit, and 61,000 lb on the 12¼-in.

Wear and Maintenance

In the early stages of this test program the rotary bit failure resulted from wearing away of the cone bearing housing, thereby permitting the entrance of dust into the bearing itself. As the diameters were increased, it was possible to reinforce and re-design the bearing housing and permit more adequate hard-surfacing in the areas subject to abrasion. In the more recent bits, this condition has been greatly reduced and failure now occurs when the cone shells wear down resulting in breakage or loss of the tungsten carbide inserts. Failure of the bearing itself is now relatively rare.

Life of the rotary bits has risen from a low of eight ft in the initial tests to an average of slightly over 1,500 ft of drilling per bit in all materials. There is no doubt that there is a lot of room for improvement in rotary bit design and construction to increase the life of the bit. At the same time the manufacturers must be commended for the remarkable progress they have made in a relatively short time.

New Hughes 9⅞-in. rotary bit, type RG-2J

It was mentioned earlier that studies were to be conducted on the relationship of drill diameter (or blast hole diameter) to blasting costs. Although work on this phase has not progressed as rapidly as anticipated, the indications are that a substantial savings in explosives cost can be made with the use of the proper bit size and with good supervision. Addi-

tional work must be done on this phase in the near future to accumulate enough information upon which to base decisions concerning changes in our blasting practices.

Mechanically, the rotary drill rigs available are generally reliable and well built. If maintained properly, the down time for repairs is less than that of other equipment of that size. The largest percentage of delay for our machine comes from moving the drill to new drill areas.

The major source of difficulty that has been encountered appears to be caused by the small percentage of the extremely fine dust produced by the grinding action of the rotary bit. Additional protection and dustproofing of the operator's cab and machinery must be provided to eliminate this problem.

On the other hand, the rotary drill, using compressed air to cool the bearings and the bit and to clean the hole of cuttings, offers several advantages over wet drilling:

1. It eliminates the problem of water supply, which, during cold weather is sometimes a difficult problem. Consequently, maintenance and labor costs on auxiliary water supply pipelines, trucks and pumps are drastically reduced or eliminated.

2. Stemming material of nearly ideal structure is provided at the collar of the hole, thereby reducing the labor and effort of "importing" suitable material.

3. Dry sampling of the hole can be accomplished easily, conveniently, and more accurately than in wet sampling—inasmuch as the fines are not subject to "prewashing" or loss due to overflows, seepage, etc., nor are the larger particles subjected to as much pulverizing action as takes place in churn drilling.

Drill stem abrasion and thread wear are also factors to consider. A few drill stems have been bent but, as in the case of abrasion, these have been successfully repaired. All of the drill-stem build-up has been done on an automatic welding machine to assure uniform and accurate surfacing.

This picture of the cab on a 50-R drill unit shows the drill stem at left foreground and the proximity of the drill controls to the stem. The drill operator has a clear view of the stem at all times

More Improvements Coming

Economically, we have every reason to believe that rotary drilling will result in substantially reduced drilling costs. Although the initial cost appears high, the cost based upon drilling capacity approximates the cost of the number of churn drills required to produce the same footage of blast hole. Cost reductions will come about through:

1. Increased drilling rate.
2. Reduction in drilling labor.
3. Reduction in maintenance labor and material.
4. Reduction or elimination of auxiliary pit services such as water supply, sludge disposal, stemming supply, etc.
5. Reduction or elimination of drill sharpening facilities and costs.
6. More uniform blast hole size, which in turn will lead to better fragmentation and more economical blasting.

In summarizing, it should be reiterated that there is still a considerable amount of testing and experimenting to be done before the rotary drill can be considered as a replacement for the churn type drill. A great deal of research and testing has to be done to develop bits of longer life and greater penetration rates. Improvements can be made to the drilling rig to facilitate moving and maintenance—all of these, we believe, will come in time. In the light of existing information and experience we think that rotary drilling on the Mesabi Range is here to stay.

More uniform blast hole sizes lead to better fragmentation and easier loading

Continuous Mining in Low Coal

Mining a face lift—Company believes that it could lower mining costs significantly by developing entries with "conventional" equipment and pillaring back with the Colmol

A factual report of one company's evaluation of continuous mining based on its own experience

By E. H. ROBERTS and G. W. LOCKIN
Respectively, Underground Maintenance and Production Engineer
Inland Steel Co.

IN this article no conscious efforts have been made to compare continuous machines, as we have operated the separate units under different natural conditions. Nor should our statements be considered a reflection on a given machine. We are attempting to factually report our evaluations of continuous mining as our experience has been to date under our mining conditions and using our methods as they concern the subject of this paper.

Inland Steel Co. owns approximately 30,000 acres of mineral in the No. 3 Elkhorn coal seam that lies in three counties in eastern Kentucky. Like many of the established companies, ours has emerged through several stages of the application of machinery at the production of coal, and doubtless will undergo more of the same in the future. Continuous mining has occupied our more recent efforts to keep our mines competitive with others in the industry, many of which possess superior natural conditions.

Seam Conditions

The Elkhorn No. 3 seam furnishes coal with good coking qualities to our Chicago steel plants. The seam contains very hard coal with little cleavage. The minable seam varies in height between 28 and 72 in., with 42 in. being the average. The seam is relatively flat, but pitches gradually to the northwest. The coal lies above stream level in this section of Kentucky and therefore our mining is confined to drift mines. Roof thicknesses vary from nothing to 800 ft with about 400 ft being the average. The coal is overlain by a variety of roof strata such as soft shale, firm shale, shale laminated with coal, sandstone, and sandstone laminated with coal. Mine bottom material varies between fire clay and fire clay that contains nodules of pyrite and other hard materials. There are some faults throughout the seam that interfere with our mining practices. We are mining coal from parting areas on the increase each year. Partings vary in height from nearly nothing to several feet in the minable seam. Normally different sections of the same mine at our properties have different mining conditions.

Mining Equipment

For "conventional" mining, a breakdown of personnel and off-track machinery for face productions is listed below. Where roof bolting is required, one man frequently is added to the crew as natural conditions or special circumstances require.

Machinery	Personnel
1—Loading Machine	1—Operator 1—Helper
1—Cutting Machine	1—Operator 1—Helper
2—Shuttle Cars	2—Operators
1—Cart-Mounted Hyd. Drill	1—Coal Driller 1—Shot Firer
1—Car Hoist	1—Timberman 1—Haulage Man 1—Foreman
Total Crew	11—Men

For continuous mining, a breakdown of personnel and off-track machinery for face production is listed below. The performance evaluations given in this paper were made on the basis of this foregoing crew and machinery allotments.

Machinery	Personnel
1—Continuous Miner	1—Operator
1—Loading Machine	1—Operator 1—Helper
2—Shuttle Cars	2—Operators
1—Car Hoist	1—Timberman* 1—Haulage Man 1—Foreman
Total Crew	8—Men

* When the continuous machine is engaged in the extraction of pillars, part of the timbering is done by the loading machine helper.

Introduce Continuous Mining

In June 1952 our first continuous mining unit, a low vein model Colmol having a cutting range of 36 to 48 in., was purchased and placed in production the latter part of that month. About a year and a half later, in December 1953, a second continuous type machine was put in service. This was a Joy continuous miner.

These two units have been in operation since that time except for periods during which they have been overhauled. In 1954 we experimented for about 12 months in low coal (35 to 37 in.) with a third continuous machine, a Joy walking miner, but subsequently discontinued the operation with this machine.

The machine we have used in our low seam work to date and the machine we will be concerned with in this paper is the Jeffrey Colmol. Although the areas worked have not been strictly what we would call low coal, we must confine this article to mining between 40 and 50 in. of seam height as the predominance of our work has been approaching or slightly exceeding the upper range of the Colmol cutting head.

Our Colmol is one of the first production models of this machine and was one of the first continuous type machines to be employed in this vicinity under our mining conditions. The main components of the machine are hydraulically operated with six hydraulic motors and five hydraulic pumps. The pumps are driven by electric motors.

Initially we were beset with many problems with this machine, some of which, as yet, remain to be solved. Several of the more significant ones are listed as follows:

(1) Training of personnel—operators, maintenance men, supervisors, and planners

(2) Very difficult cutting due to hardness of coal and lack of cleavage planes

(3) Adapting the machine to seam conditions in areas where rapid extraction might be possible

(4) Altering some of the components on the machine for improved performance

(5) Size of machine made it somewhat inflexible to mining system.

The initial adjustment period lasted 14 months during which 33,120 tons of coal were mined at a daily shift-rate average of 13.00 tons per man.

At first soft bottom interfered quite seriously with the performance of the Colmol since this machine depends on tractive effort to provide thrust for cutting from the solid. Several alterations were made to the caterpillar treads to give increased traction. Meager success has been achieved, although we feel this problem has not been completely solved. Since this period, we have not operated the machine in soft bottom areas.

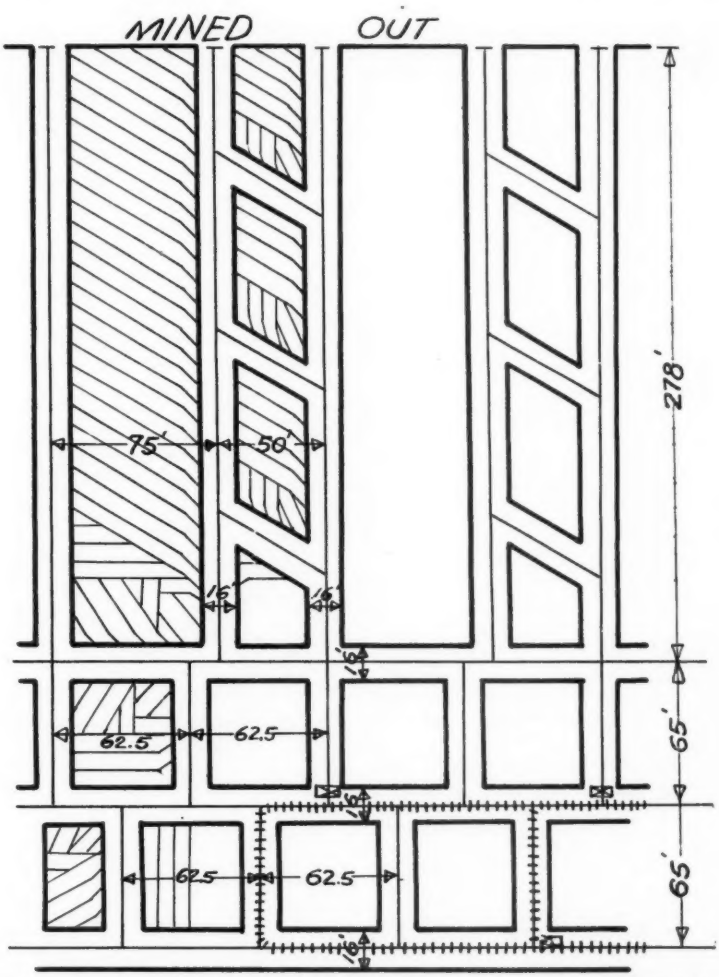
During the introductory period, much difficulty was experienced with hydraulic motors and pumps. The machine utilizes six motors and five pumps in the hydraulic system and 25 pumps and 18 motors were replaced during this period; however, the expense was borne by the Jeffrey Manufacturing Co.

We commenced continuous mining with the preliminary acceptance of the premise that the machine would best adapt itself to solid seam work at our mines. This we have found not to be true because of the difficulty of cutting the hard coal. In pillar mining (complete extraction system) additional weight from pillar extracting causes the coal to break much easier and in larger sizes, thus allowing faster penetration.

Present Mining Plan

After the introduction period, it was decided to place the machine on pillar mining. From the first pillar plan, a second was devised, and then a third before a satisfactory mining plan was arrived at for this machine. We have continued to use this third plan and feel that it has provided the best answer to date.

Entries are developed on 65-ft



Present plan for pillar mining with Colmol calls for rooms to be developed on only one side of the entry to varying depths, usually 250 to 280 ft, on alternate 50 and 75 ft centers

centers. Rooms are developed on only one side of the entry to varying depths, usually between 250-280 ft, on alternate 50 and 75-ft centers. A solid block is left between rooms on 75-ft centers for the full depth of the room to afford better roof control, less timbering for lifts, and less rock to be loaded. This projection is designed to favor two shuttle-car haulage from the room since the bulk of the tonnage mined is hauled through the rooms. Mining of chain pillars has not presented a serious problem to date, primarily because they are few in number and block size seems to be adequate for our conditions.

Performance Data and Comparisons

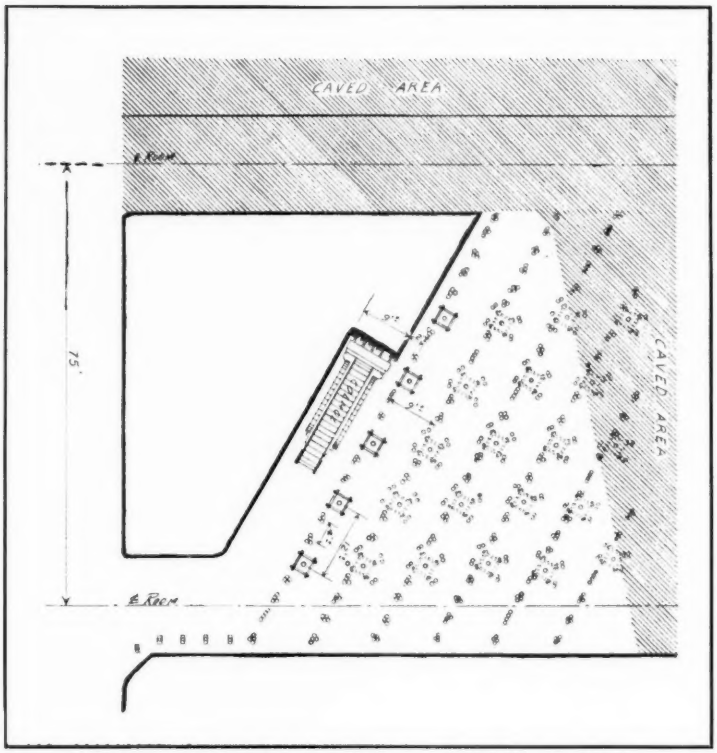
For purposes of comparison, we will use the results from a section where two entries were driven up and pillared back, one entry 1400 ft and the other 1800 ft deep. The 14-month experimental period will be excluded.

Average production per man shift on entry development was 19.1 tons and on pillaring back, 25.0 tons. During this time, maintenance costs were quite high, averaging about 66 cents per ton for the Colmol alone. This, plus maintenance costs for auxiliary equipment on the section, exceeded the section labor cost. Total maintenance costs on the Colmol section exceeded "conventional" maintenance costs by about 58 cents per ton. The reduction in labor and supply costs gained by using this machine, however, is sufficient to lower the over-all section cost between zero and six cents per ton less than "conventional" costs under similar mining conditions.

We are at present striving to lower this total cost even further. If we should develop our entries with "conventional" equipment and pillar back with the Colmol, we think we could lower the mining costs significantly. The day has already arrived at some operations where maintenance costs do not usurp the advantages to be gained from the high productive capacities delivered by continuous machines.

Problems to Be Solved

We feel that our main problem to this time has not been operating this machine in coal that approaches the lower cutting height, but that natural seam conditions forces the machine to do a large amount of hard cutting and not enough breaking of cores. We have had much conveyor chain trouble with the original three-strand conveyor chains. Currently the Colmol is in the central shop for overhaul and we are changing to a two-strand conveyor chain along with increasing the throat area at the front of the machine in an attempt to rectify this problem. Jeffrey now has a hydraulics repair shop at Columbus,



Minimum timbering plan for extraction of pillars with the Colmol

Ohio, with several new machines for providing closer tolerances for hydraulic units. This should mean that we can henceforth count on better and longer performances from hydraulic pumps and motors.

In our poor roof conditions, continuous mining keeps shock from the roof and aids in controlling the roof. In pillar mining, continuous machines generally work in one location until it is finished, thus there are fewer open places standing or "taking weight" as in "conventional" mining.

Problems of the kind listed below should be solved before a machine of this type can best serve our needs.

(1) It is not built as low as we would prefer it to be. We have difficulty mining below 40 in.
(2) This machine does not perform well in soft bottom.
(3) Size of machine and auxiliary units interferes with timbering and roof control practices.
(4) Continuous noise from the unit interferes with men listening for roof settlement.

We have made some progress from our first attempts to use continuous mining at our properties. We are still learning and we still have to select conditions suitable for this new system, but from our experience to date, we are optimistic and feel that this new element has a place in our planning for the future. We believe a machine will eventually be built that will overcome most of the problems mentioned in this paper.

Conventional loader behind continuous machine

This general view of the Crestmore area shows the ramp, overhead trolley system, mill and crusher facilities, and the old headframe. Electric trucks move up the ten percent grade with full load at about 12 mph

New Underground Mining At Crestmore

Summary of a well-planned program for expanding and modernizing a large underground limestone mine, utilizing a modified room and pillar system and high capacity equipment

By R. H. WIGHTMAN
Superintendent of Mining
Riverside Cement Company, Crestmore Division

MANUFACTURE of cement was started at the Crestmore Division of the Riverside Cement Co., about four miles northwest of Riverside, in 1909. Surface limestone was quarried and hauled to the crusher with mule carts, and later by rail mounted steam shovels and trains. In 1927 an underground block caving system of mining was started and used until 1941, at which time electric shovels and diesel trucks were used to produce quarried limestone in conjunction with the underground mine.

The underground mines was shut down February 6, 1954 because of the depletion of developed reserves. Economic aspects of deeper mining by the caving system were unattractive because of the physical change in the rock structure at depth and the perched water table.

In 1949 it was decided to review the limestone reserves adjacent to the Crestmore plant. Three diamond drills were purchased and an extensive drilling program was conducted until the middle of 1953 to determine the extent and values of the two known limestone beds.

About the Author

R. H. WIGHTMAN graduated from the Missouri School of Mines in 1927 with a B.S. degree in mine engineering. In 1949 he was granted an E.M. degree in mine engineering.

Employed by the Riverside Cement Co. April 1928, he has worked successively as mine transitman, mine engineer, mine superintendent, superintendent of Ore Grande Division, and superintendent of mining.

Crestmore Deposit

The Crestmore deposit consists of two limestone beds which outcrop at the surface and are separated by about 500 ft of quartz diorite. Strike is north and south, dipping to the east at about 45°. Going down the dip, the beds tend to flatten out to a dip of around 25°. To the east the two beds tend to converge upon one another until they are separated by only 100 ft of quartz diorite.

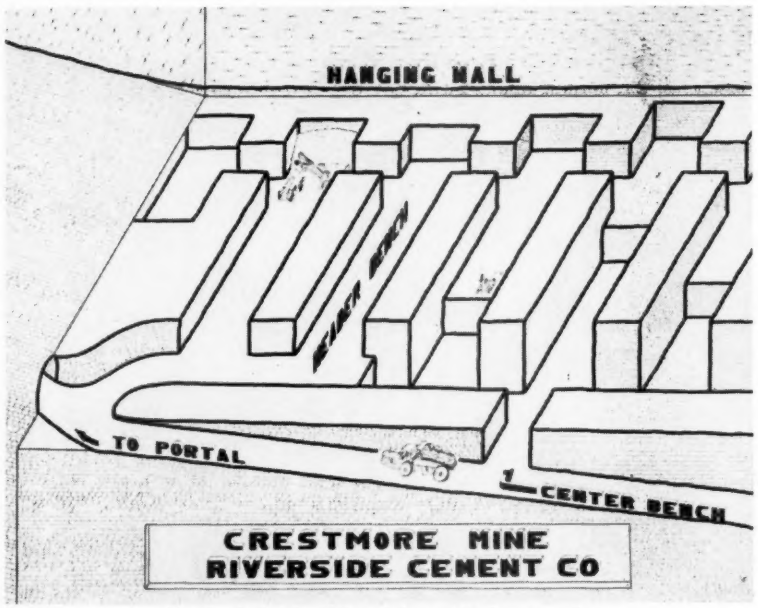
Limestone in both beds is a crystalline, metamorphosed rock with varying amounts of brucite. Beds are approximately 2500 ft long, along the strike, cut off at each end by quartz diorite; and vary in thickness between the hanging wall and footwall from 200 to 300 ft. The upper bed and the north end of the lower bed are covered with alluvium that is water saturated.

At the north end there is a clay seal between the limestone and the water saturated alluvium which tends to prevent water entering the lower bed.

All diamond drill holes were surveyed with a Tro-Pari Bore Hole Surveying instrument. All core was photographed before splitting and enlarged to a scale of two in. to the ft for the purpose of having a permanent record illustrating the fractures and other planes of weakness. Facilities were installed in all holes drilled through both beds so that the water elevations in each could be determined separately. Core was split and complete chemical analyses made.

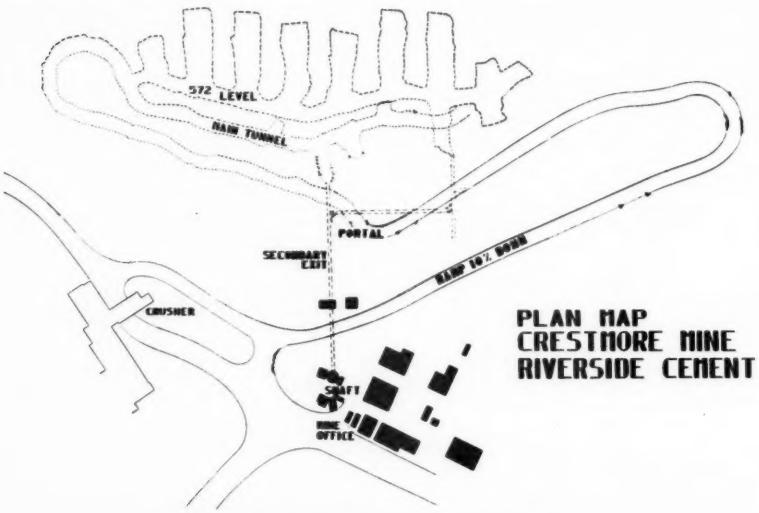
Water Table Lowered

It was known from operating the original mine that the water table in the lower bed was lowered 180 ft and maintained at this level for 20 years without affecting the water elevation in the upper bed.



Idealized sketch of the mining method proposed

A test water well was drilled during the early stages of the drilling program to determine if the lower bed could be dewatered to a lower elevation by pumping from a well without affecting the water table in the surrounding area. From this it was determined where to drill a second well of sufficient capacity to dewater the deposit. After the well was completed, a pumping test was conducted for two weeks. All diamond drill holes in the area were measured at frequent intervals to determine the amount of water to be pumped to lower the water table in the lower bed. Upon completion of the pumping test a Byron Jackson submersible pump was installed.



Map of the actual mine as of June 1, 1956

Large Openings and Equipment

Numerous underground mines, as well as the experimental mining of oil shale conducted by the U. S. Bureau of Mines at Rifle, Colo., were visited to observe the various methods in use and to see the latest types of equipment in actual operation.

Based upon our experience in block caving, results of the diamond drilling, and visits to various mines, it was believed that methods utilizing large openings and heavy equipment would be adaptable to our deposit.

Philip B. Bucky, professor of mining at Columbia University, was retained to make strength tests of the rock and submit his opinion of mining the deposit with large openings. As a result of this work, it was indicated that a system of mining with large openings and equipment might be feasible.

Based upon Bucky's findings and our opinions, it was decided to utilize a modified room and pillar system of mining. E. D. Gardner, chief engineer of the U. S. Bureau of Mines, and Emery Sipprelle, general superintendent of Mississippi Limestone Company's mines, confirmed the feasibility of the proposed system of mining. W. P. Rowe, a consulting hydraulic engineer, assisted with the water problems that had to be solved.

Two Models Made

After the general plan of mining had been decided upon and all of the geologic information concerning the deposit assembled, two models were made to demonstrate the general fea-

tures of the deposit and the proposed mining plan to non-mining personnel.

One model was made to illustrate the geology, ground water condition, and surface features of the entire deposit. This model was made from clear plastic on a scale of 100 ft to the inch and covered an area 2500 ft by 3200 ft to a depth of 1500 ft below the surface. The plastic was colored with various colors of transparent, fluorescent lacquers to bring out the upper and lower limestone beds, the water table, alluvium, diamond drill holes, and surface features. By viewing the model under either plain bright light or ultra-violet light, various phases of the deposit could be demonstrated.

The other model, made from a solid plastic foam material, was designed to show the general method of mining. The model, at an approximate scale of 20 ft to the in., was made in three pieces which came apart along the footwall to show the access tunnel, the first level of three cuts with rooms and pillars almost complete, and a second level started beneath a floor pillar. Naturally this model, though to an approximate scale, illustrated the proposed mining method in a much simplified and idealized form.

Proposed Mining Plan

The mining method proposed would involve driving a sloping road down the footwall side of the ore body at the maximum reasonable grade and turning off a level drift as soon as possible under the old mining workings. From this level drift rooms would be turned at right angles to the strike, leaving pillars for roof support. When sufficient rooms were opened up, a turn-off from the sloping tunnel below the rooms would be made and benching would extract an additional cut of limestone. A third turn-off from the slope will be made, allowing a second bench to be made in the rooms. Thus, two-thirds of the rock will be mined by ordinary quarry methods.

The Mine

The ramp down through the old block caving area was made using conventional quarry equipment. As soon as solid rock was reached, the open cut was changed to a tunnel and the mine was started.

The main tunnel was driven down on a grade of 10 percent along the footwall, but in limestone so that the material could be used by the mill. At 572 ft above sea level a 60-ft floor pillar was left between the old mine haulage level and the new mine back so the first level was started. The main tunnel was continued downward, turnouts made for the next two benches and connections made with the old mine workings for ventilation and second exits.

After the tunnel was well clear of the portal area, the concrete portal was built and the first 70 ft of tunnel was gunited as the ground was rather gravelly in this area. Guniting was done by contract over 4 by 4-in. wire mesh installed by the Riverside Cement Co. with 14-in., 6-ft and 8-ft roof bolts on 4-ft centers, depending on the ground requirements. Portable rented scaffolding was used and one way traffic maintained throughout the job.

All new workings in rooms and the main tunnel are roof bolted where necessary, using Colorado Fuel and Iron Corporation's standard ¾-in. roof bolts. Six-in. square head washers are used, except that in questionable locations we have recently started using B. F. Goodrich roof bolt compression pads to check the holding power and the loading on our bolts.

Pitman Giraffe, mounted on one of the old diesel quarry trucks, is used for loading holes and scaling in the rooms. To the left is an Ingersoll-Rand jumbo that mounts four 505 wet drifters

Jumbo Mounts Two Drifters

A special jumbo built by the Rogers Iron Works of Joplin, Mo., was used for drilling in the main tunnel. This unit mounts two I-R 505 WD drifters (four-in. machines) on hydraulic booms. Booms have power hoist and swing. The dump and cut angle must be set by loosening a traditional bar clamp. The feed is long enough to change 20-ft steel; however, we rarely use more than 18-ft steel. The platform which carries the boom arms is hoisted up and down the folding mast by an air hoist. Propelled by two air motors driving crawlers independently, the jumbo is capable of drilling level holes about 29 or 30 ft off the bottom and parallel holes 32 ft apart. Normally the tunnel is carried 30 ft wide by 27 ft higher at the center. At times we have carried it 28 ft wide by 22 ft high, and recently 32 to 34 ft wide for additional clearance in good ground. A round consists of from 50 to 75 holes drilled in a simple "V" cut pattern. The number of holes is varied by the drill crew according to the type of ground being drilled and the condition of the face. The depth of round drilled is generally about 10 or 12 ft, although in good breaking ground 15 ft can be pulled. There is no advantage in breaking more ground than the shovel crew can handle in one shift.

The jumbo crew can usually move in, scale down, and drill out a round in a shift. We have drilled out, loaded and shot in a shift but usually the cycle takes one shift to scale and drill; one shift to load, blast and scale; and one shift to muck out. The powder crew will generally consist of two men and part of the time a helper to run the powder rig for the top holes. We use 1½ by 16 in., 60 percent powder with milli-second delays for blasting.

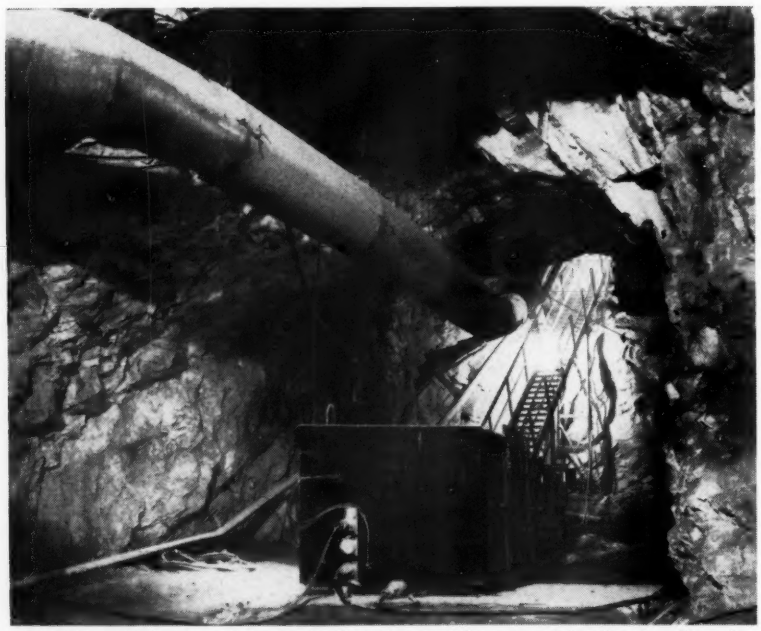
The rig used for scaling and powder

Marion 43-M electric shovel loads into a Westinghouse-LeTourneau Model C. Tournarocker

work was made on an old diesel quarry truck frame and can lift two men up to a 30-ft back.

Shovels and Tournarockers

Rock from the tunnel is loaded by a Marion 43-M electric shovel, equipped with short boom and sticks and a 1¼ yd bucket. It is a friction machine with air boosters and can work in an area 20 ft high and 27 ft wide. Westinghouse-LeTourneau Model C. tournarockers, equipped with exhaust gas scrubbers, are used in conjunction with the shovels. These units can make a "U" turn at the end of the tunnel, thus saving considerable backing into the shovel. Normally four units are used to haul from the face of the tunnel to the crusher, a distance of a little over one mile. Their minimum turning radius is 13 ft 6 in.



The General Electric underground sub-station furnishes current for the shovels and auxiliary equipment. Also shown are the steel ladders for the second exit to the main shaft and the three ft diam ventilation pipe serving the main tunnel

Drill 120 Holes Per Room

An Ingersoll-Rand jumbo, built for drilling in the rooms, mounts four 505 wet drifters and is hydraulically operated. Two men operate the four machines and can drill up to 22-ft holes without changing steel. The machine is propelled by air motors and levelled with hydraulic jacks. Normally two settings drill out a 60 by 32 ft high room. The round generally used is a single "V" cut, with the cut in the center. Approximately 120 holes are required for a 60-ft room. The depth of round is approximately 15 ft and an entire round has been drilled out in ten hours. The pillar left between rooms is 50 ft wide.

All drilling is done using tungsten carbide bits and without steel changes. Our average footage per bit to date is 2090 ft.

Drilling the down holes on the benches is done with two Gardner-Denver Air Trac drills. These drills are 4½-in. wet machines, using 10-ft jointed drill steel.

A Pitman Giraffe, mounted on one of the old diesel quarry trucks, is used for loading holes and scaling in the rooms. This rig will be used to reach the back after the first bench is completed. Hydraulically controlled, either from the ground or the basket, it can reach to a height of 65 ft.

Electric Truck Carries a 30-Ton Load

Loading in the rooms is done with two Marion 93-M electric shovels, equipped with short boom and sticks and a three-yd bucket. To provide sufficient power for the three-yd bucket, a Marion No. 111-M motor generator set was installed. These shovels can operate in a room 28 ft high and 45 ft wide.

The electric shovels load into Kenworth 802-E electric trucks specially designed to meet our requirements and carry a net 30-ton load. The truck frame, body, differential and steering are standard 802 design. The diesel engine, transmission and clutch have been replaced by a General Electric 350-hp, 550-v, d-c, traction motor. Auxiliary power for dumping, compressed air, power steering and generator for standard automotive lights is provided by a ten-hp, 550-v, d-c, General Electric motor.

The control circuit was designed by General Electric and Kenworth to provide two stages of dynamic braking on down hill grades and six steps for starting. These trucks operate under a standard trackless trolley system designed by Ohio Brass Co. When backing under the shovel, they use a gathering type locomotive reel extension cable. The reel can handle 450 ft of cable, which is plugged into protective panels located near the face of each room.

(Continued on page 78)

The company has a qualified master mechanic equipped with a truck and necessary tools going from job to job checking every piece of equipment. As a guide he uses a preventive maintenance check list on which he notes defects. One copy is turned over to the chief job mechanic for correction and the other copy to the job superintendent for follow up

Maintenance of Strip Mining Equipment

By W. C. M. BUTLER, JR.
Vice-President
Central Pennsylvania Quarry,
Stripping & Construction Co.

Author points out the importance of properly organizing a maintenance department to provide preventive maintenance, field maintenance, shop repairs and efficient records

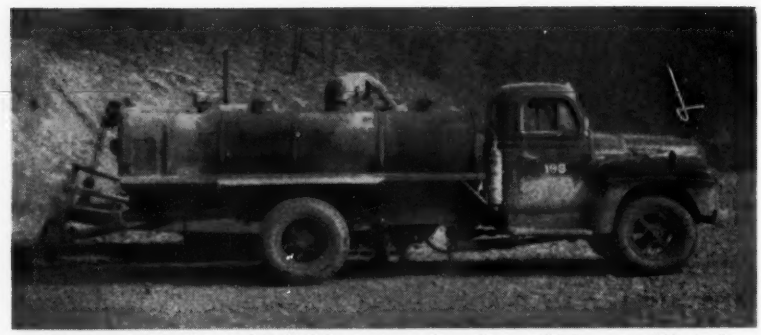
MAINTENANCE of equipment is the most important single function of any successful operation, but it is a subject which has never been satisfactorily solved. Since the "Maintenance of Strip Mining Equipment" covers such a wide field, the procedures outlined hereinafter will be of a general nature. Equipment maintenance takes a well-planned program that is rigidly enforced. Like the Army, there must be a chain of command with each person having a definite responsibility and duty.

Organization

In our organization we have the following set-up in which an officer of the company has a very definite place. The shop superintendent and the maintenance superintendent must work hand in hand as their duties depend on each other, and the purchasing agent has to work closely with each of them. The job superintendent, while responsible for maintenance, has to work under the control of the maintenance superintendent. It has been found that if a job superintendent needs a truck, he will run it even when it should be shut down, but the maintenance superintendent has full authority to shut down any piece of equipment he sees fit. However, the job superintendent is responsible for the preventive maintenance on his job.

In order to keep a closer watch on equipment the company has a tire man and a roving preventive maintenance man who work directly under the maintenance superintendent. These are the men who really save the most money. They check closely on each and every piece of equipment and learn from the operators of any troubles the equipment might be having. They report all troubles to the job mechanic and to the maintenance superintendent.

Since maintenance plays such a big part in the ultimate cost of an opera-

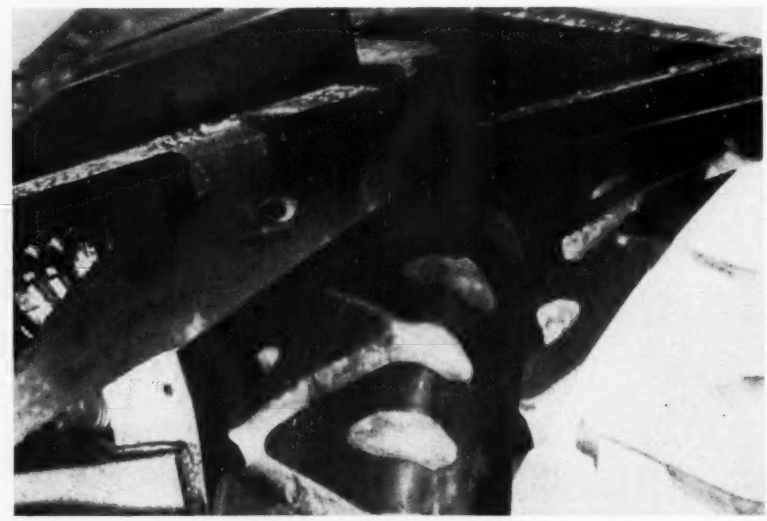


Servicing and fueling is handled by an experienced man driving a mobile tank truck. Fuels are delivered to the equipment wherever it may be

Lubrication truck carries all necessary oils and greases. This phase of maintenance is the responsibility of the job superintendent, who receives the technical advice and recommendations of the oil company servicing the account

tion, we find it necessary to have a large plant at a central point. The main offices and plant are combined. Here we have a shop, a warehouse, and storage buildings and yards. The shop is equipped as a complete machine shop with lathes, milling machines, saws, and slotters. The welding department has presses, benders and small treaders as well as the usual welding and blacksmith equipment. Other areas are for the mechanics with their usual tools.

The supply house maintains a stock of parts, tires, cables and electrical equipment which amounts in dollars value of about two per cent of the annual gross receipts. We maintain a pool in conjunction with other contractors in the area with similar equipment. This has been very successful since many of our competitors use the same types of draglines as we do.



Rock ejectors give better tire hours

Importance of Preventive Maintenance

In the past few years, we have been concentrating more and more on preventive maintenance. The preventive inspections and services are designed to adequately and economically maintain the vehicles and equipment in a safe and standard operating condition. It is the responsibility of each job superintendent to maintain and schedule the following maintenance program for his equipment:

(1) Inspectors and scheduled maintenance services are performed by the vehicle operators such as checking fuel, oil and water before starting operations, checking for leaks and brake failure, checking tires. If the driver or operator takes a sincere interest in his piece of equipment, preventive maintenance is not such a large problem. We have found that a driver or operator will take a better interest in his work and equipment if he can run the same piece of equipment each day. Instruction to the operator by the maintenance force as to proper gearing is of vital importance. Improper driving is a major factor in mechanical failures and inexperienced or careless drivers can nullify all efforts to maintain equipment properly.

(2) Servicing and fueling again is the responsibility of the job superintendent. But it is handled by an experienced man driving a mobile tank truck furnishing fuels to the equipment wherever it might be. Unless our trucks are passing a given point where fuel might be stored, we have found that more time is saved and less production lost by using the tank truck. Early quits and running off during the shift for fuel or for one excuse or another is costly. All of this gives us a clear picture as to the consumption of the vehicles.

(3) Lubrication comes next in organizational maintenance with a lubrication truck that carries all necessary oils and greases and an operator schooled in the proper greases and grease application. Here again this is the responsibility of the job superintendent, together with the technical advise and recommendations of the oil company servicing the account. Most major companies furnish lubrication surveys and recommendations for every type of equipment.

(4) Road Maintenance is last but not least. While not directly related to machine maintenance, this item probably has more bearing on breakdown of trucks than any other source. It is almost always true that an operator who maintains good roads, maintains his equipment likewise. A dol-

lar spent in road maintenance is a dollar saved in equipment maintenance.

Field Maintenance

Our field maintenance is performed on the job by qualified mechanics and normally is limited to the tearing down and replacement of unserviceable parts, sub assemblies or complete assemblies. Except for shovels, all major overhauls are made in the shop. Assemblies are sent out from the shop for the replacement and the broken or worn out units are returned to the shop.

As an aid to field maintenance, a parts trailer has been developed to furnish the job with basic parts for minor repair. Each trailer has a standard inventory set up and approved by management. As a part is taken from the trailer, its number, its item nomenclature and piece of equipment using it, are listed on a parts requisition pad and sent into the main shop daily. At this time it is requisitioned from our main stock room and replaced in a matter of two or three days.

Shop Repairs and Rebuilding

Preventive maintenance is the most important part of any operation, but it cannot and does not answer the complete problem. We maintain a shop for the repair of material or equipment that requires a major overhaul or a complete rebuilding of parts such as sub assemblies or complete assemblies. Such maintenance is intended to augment stocks of serviceable equipment to support lower levels of maintenance by the use of more extensive shop equipment and personnel.

Through records and inspections we determine when a given piece of equipment should be brought into our shops for major overhaul. As an example, we keep a record of every motor and the number of hours it has worked. When it has reached close to 5000 hours, we try to schedule that piece to come into the shop. However, we also have records on its oil consumption and reports on its power; if these show it is not operating properly, we then bring it in for a general overhaul. When brought in, the truck is completely torn down to the frame and rebuilt, including box, cab, differential, transmission and motor. Other types of equipment are given similar treatment and come out looking like new as well as giving the service of a new piece of equipment at a fraction of the price.

Another very important function of the shop maintenance program is the rebuilding of sub assemblies such as transmissions, motors, etc. Here we make extensive use of our machine shop, welding shop and motor shop, where specialized personnel do a fast efficient job at low cost.

Our welding shop is kept busy rebuilding dragline buckets which are brought in rather than repaired in the field. We find that cracks not seen on the job show up when the bucket is cleaned. These men also repoint all of the dipper teeth.

Tires—Most Expensive Maintenance Item

Also falling under the shop maintenance program is our tire program. Here we have a specialist equipped with a compressor truck who covers all of our operations, checking every tire pressure as well as tire condition. Removing tires at the right time for repairs is one of his most important functions. A tire need not be flat to be removed. In addition every road tire is given a Q number and a complete record is kept of the actual hours of its service. This card tells the cost of each repair as well as any adjustment which might have been made.

Tires are our most expensive maintenance item and therefore we feel it must be the most closely watched item. To check what our tire man is doing on the job, the various manufacturers send their representatives around periodically and give us a written report on their findings as to the air pressure and condition of our tires, as well as the driving condition of the equipment. We find this most helpful.

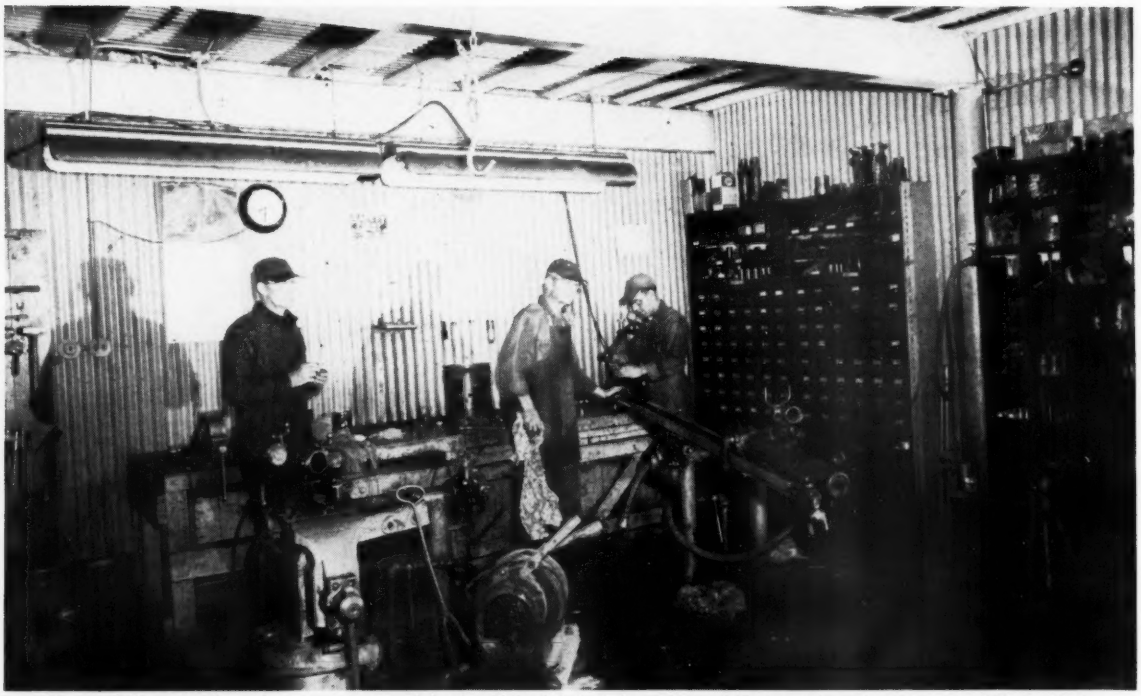
Records

In line with the tire man, we have a qualified master mechanic equipped with a truck and necessary tools going from job to job checking every piece of equipment. As a guide he uses a preventive maintenance check list on which he notes defects. One copy is turned over to the chief job mechanic for correction and the other copy to the job superintendent for follow up.

In addition, our shop checks all new equipment recently purchased to strengthen weak points such as reinforcing beds on truck bodies, adding rock ejectors to give better tire hours, building up weak points on new buckets and various little details we have picked up to keep maintenance costs to a minimum.

We have found that preventive maintenance is our big weakness, but we feel the steps we have taken have saved us much in breakdowns and loss of production. If you can educate your foreman to educate his men, you will end up with a sound preventive maintenance program.

Tires are the company's most expensive maintenance item; consequently they are the most closely watched item. A specialist equipped with a compressor truck covers all of the operations, checking every tire pressure as well as tire condition



Climax drill repair shop—Just as an automobile should be lubricated and inspected at certain mileage, a rock drill should be brought in for inspection at certain footage

Standardization of Measurements In Underground Drilling

Accurate records based on standardized measurements of underground drilling have been made at Climax for the benefit of the company and drill runner alike. The same achievement is possible throughout the mining industry

By R. M. STEWART
Assistant Planning Engineer
Climax Molybdenum Co.

WHEN the tungsten carbide bit came into general use at Climax, it was soon apparent that more complete records would have to be devised to check performance and costs. In order to achieve as much accuracy as possible in these bit reports, as well as other drilling equipment, Climax decided to base all measurements on the footage drilled. That is, performance and unit costs were based on foot of hole drilled. This decision was reached from these considerations:

(1) This is the simplest, most basic measurement possible.

(2) It is independent of the mining cycle, whether drifting, raising or stoping.

(3) It is independent of the mining method, whether caving or selective stoping.

(4) It is the only direct comparison between test and production drilling.

(5) It is the only accurate basis for unit drilling cost in a block caving operation. While a unit drilling cost of "cost per cubic foot" or "cost per ton" is valuable in some reports, these unit costs are not sufficiently accurate for a caving operation, because there exists no fixed relationship between the amount of rock actually removed in preparatory work and the amount of rock developed and caved.

As a result of standarization, two main reports were developed:

(1) Accurate performance reports of drilling equipment.

(2) Accurate cost report of drilling equipment.

The advantages gained from these reports are:

(1) To keep the company manage-

ment and supervisors advised of the trend in performance and unit costs of the drilling equipment.

(2) To advise the mine supervisors of the differences between production performance and costs and the test performance and costs.

(3) To develop accumulative figures on past performance and costs for comparison with current performance and costs.

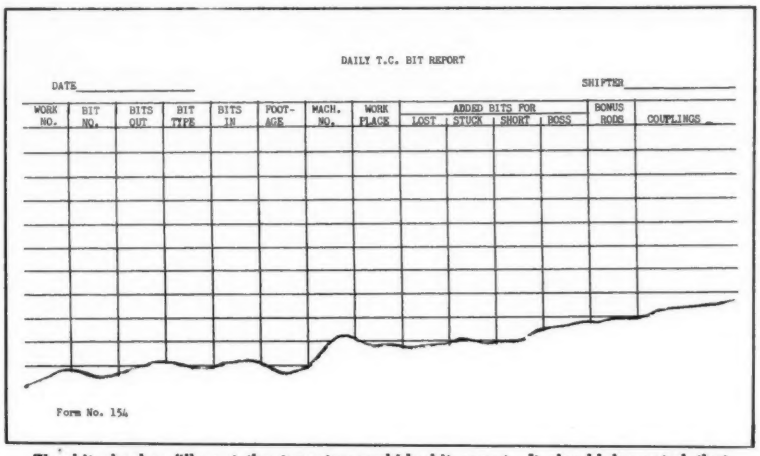
(4) To recommend purchase of new equipment that test work shows to be superior to equipment in current use.

When these records were established, it became obvious that a test program had to be set up to determine standards for performance and unit costs. These standards could then be compared with production performance and unit costs to show where there was room to improve the production results to meet the test results. The details of this test program will be given later.

Preventive Maintenance Program

Another advantage that Climax gains from this standardization is that it will keep the repair and maintenance of rock drills under stricter control. At present we believe the following policy can be established—a preventive maintenance program for rock drills based on the footage drilled by the machine. This plan requires the closest cooperation on everyone's part, from the miner turning in his daily footage, to the engineers who design the machine.

The plan operates along these lines:



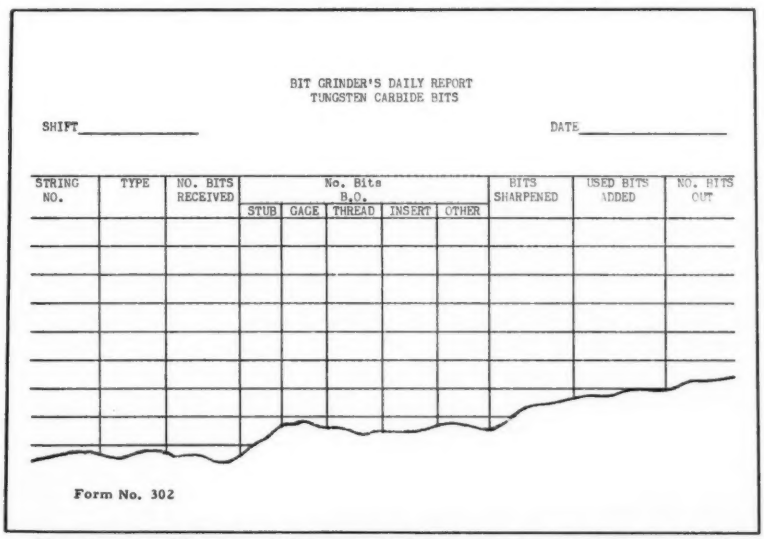
DAILY T.C. BIT REPORT

DATE_____ SHIFTER_____

WORK NO.	BIT NO.	BITS OUT	BIT TYPE	BITS IN	FOOT-AGE	MACH. NO.	WORK PLACE	ADDED BITS FOR LOST	STUCK	SHORT	BOSS	BONUS RODS	COUPLINGS

Form No. 154

The bit checker fills out the tungsten carbide bit report. It should be noted that only the bit checker adds new bits to the string. This gives the company good control over the issue of new bits



BIT GRINDER'S DAILY REPORT
TUNGSTEN CARBIDE BITS

SHIFT_____ DATE_____

STRING NO.	TYPE	NO. BITS RECEIVED	No. Bits B.O. STUB	GAGE	THREAD	INSERT	OTHER	BITS SHARPENED	USED BITS ADDED	NO. BITS OUT

Form No. 302

The sharpener fills out a daily report that serves as a cross-check on the bit checker's report

About the Author

RAYMOND M. STEWART obtained his degree in mining engineering from the Colorado School of Mines in 1950. After working in the mining engineering department of the Anaconda Co. for two years, he was transferred to the engineering research department to work on drill equipment testing until July 1954. He then moved to the planning department of the Climax Molybdenum Co. where at present he is in charge of all testing of drilling equipment.

(1) When a machine comes out to the shop for repair, the total footage drilled will be checked.

(2) On the basis of this footage, specific parts replacements would be made in addition to the repair and replacement of damaged or broken parts.

(3) Machines not sent out to the shop due to damage, would be brought out from underground when the footage drilled indicated they were due for inspection.

Just as an automobile should be lubricated and inspected at certain mileage, a rock drill should be brought in for inspection at certain footage. Through this preventive maintenance, parts will not be left in the machine that are so worn that they may cause damage to other parts of the machine.

It is the responsibility of the rock drill manufacturer to determine when machine parts are so worn they should be replaced. It is also their responsibility to recommend the gauges and other measuring devices, and to furnish the plans that most easily and accurately show the maximum limit of wear. It is then the responsibility of the owner to use these instruments and plans as recommended and to determine the footage at which the limit of wear occurs.

When this has been accomplished, a single standard operating procedure can be set up to show what repairs and replacements will probably be needed when a specific footage has been drilled. This control, based on standard measurements, can mean lower maintenance costs and longer drill life.

Standard Test Procedure for New Drills

An extensive test program was begun to provide the facts and figures to be used as an accurate, impartial basis for rating drilling equipment performance and costs. This test program would develop better drilling equipment and establish standards of performance and costs for this equipment.

First, arrangements were made with the mine department to use an area of the old grizzly level above the Phillipson for test work exclusively. This level is no longer part of the active mining area, yet it is readily accessible.

Hardness of the ground in the area was checked by running a speed test with a 90 lb stoper using a 1½-inch bit with "F" thread on a four-ft. ⅞-in. hex collared steel with 4¼-in. shank. The ground was considered "hard" if the drilling speed was less than 20 ipm. When this drilling speed was below 15 ipm the ground was considered "very hard." This control is maintained for all bit, drill steel and machine speed tests.

Standard test procedure of new drills is fairly simple. When a new model or machine is developed by the manufacturer and brought to Climax for trial, the machine is sent to the test stope. It is put through a break-in period of drilling at least 1000 ft. Then a speed test is made against similar drills or the drill it might be expected to replace. In any case it is always run against a machine whose performance is known. It is also checked for operational characteristics and performance. Probable maintenance costs are also checked. At the end of the controlled tests, the machine is sent to the mine crew. It is then checked regularly by the test engineer for the miner's opinions. Maintenance costs are kept under close scrutiny. If all factors are favorable, a report is made recommending its purchase when the need for more machines arises. It is accurate and impartial, and has proven itself to be such during the past two years.

Bit Testing Program

When the bit testing program was begun in earnest some two years ago, it was necessary to run tests on the bits in mine use at that time to establish a standard. Then we began the testing of new and experimental bits. In these two years, great improvements have been made in tungsten carbide bits; in fact the improvement in bits during these past two years has shown a marked increase over any similar previous period.

When a bit has made a superior showing in test work, a small lot is purchased and put in use with some of the miners. These men are asked to keep track of the bits and give us their opinion of them. In the majority of cases they approve of the change. When all factors are favorable, the changeover is made to the new bit as soon as possible.

Employe's No. .....Date .....
String No. .....Working Place .....
Feet Drilled .....
Hrs. Opr. .....Machine No. .....
..... Code .....
Check one: .....

...Drifting	...Ldg. Cutouts	...Vent Overcasts
...Raising	...Vent Drifting	...Other
...Undercutting	...Vent Raising	
...Longholing	...Vent Connections	

The bit card is filled out by the miner at the end of the shift and attached to his string which is turned in to the bit checker

In the course of testing bits, some interesting discoveries have been made on the carbide wear distribution. This is important information that has proved to be worthwhile in developing improved bits. In order to show this wear distribution, the test engineer measures the height of the insert of each test bit at the start of the shift and at the end of the shift. In this way the following information is obtained:

(1.) The amount of insert actually used for drilling.
(2.) The amount of insert lost by sharpening.
(3.) The amount of insert left in the bit at failure.

Thus, in addition to getting the average footage per bit we also get the average footage per unit of carbide. This figure shows the insert's true performance, irregardless of poor sharpenings which make appreciable differences in the average footage per bit.

Recommendations to Manufacturers

With complete data available to show the carbide wear distribution, positive recommendations to bit manufacturers were made to improve the bit. The first major recommendation made was to increase the clearance grind, or chipway, between the wings of the bits. The value of this is obvious. By increasing the clearance between the wings of the bit, the size of chips being removed from the bottom of the hole is increased. This means faster drilling since more primary and less secondary chipping is done. Tests have shown that drilling speed has been increased by nearly 15 percent with this design change and the bit footage has been increased by over 30 percent.

The second recommendation was in

Form No. 286 — REPAIR COSTS - MINE ROCK DRILLS — Month

Class	No. in Service	Units Repaired		Footage Drilled		Total				Per Machine		Cost Per Foot	
		Month	To Date	Month	To Date	Parts	Labor	Month	To Date	Month	To Date	Month	To Date
Drifters													
Stopers													
Jackleg Drills													
Jackleg													
Trial Machines													
Miscellaneous													
Total													

Total repair costs and total footage give the over-all cost per foot of hole for all machines on both levels

regard to the water holes in the bit. Previously, standard bits had three water holes—one center hole, and two side holes on opposite sides of the bit emerging at 45° about midway between the bit wings. These two side holes at 45° cause turbulence in the water flow and do not facilitate cutting removal from the bottom of the hole. Therefore, it was recommended that four side holes at 60° to 70° be used. Then all water from the bit would be directed at the bottom of the hole to flush out the cuttings. The four side holes are half the diameter of the center hole, which gives them a slight jet effect for faster flushing. This change improved bit life about five percent.

The third recommendation was that harder inserts be tried. Some previous work had been done in this direction with only inconsistent results. However, with the improvement in cutting removal gained by the extra clearance grind and additional side holes, we believed that the harder insert stood a better chance of lasting for its full life. Some varying grades of hardness of inserts were tested and one was adopted for general use that lengthened bit life about 15 percent. Further tests are being made with even harder carbides that show promise of increasing our present bit life another 50 percent.

Tests have shown that an average of 50 percent of the height of the insert is left in the bit at failure. Drilling and grinding have worn away the other 50 percent. It would seem logical to assume that this same residual height of carbide, or same carbide mass, should be left in the bit at failure no matter what the original height of the insert. Thus, if 3 mm is added to the original height of carbide, and the mass of carbide remaining at failure remains constant, there would be 3 mm more carbide available for drilling and sharpening.

This standardization in test work has proven equally as valuable to the manufacturer as to Climax; it is responsible for the development of better drills and better bits. With results from two years of test work, we now had the necessary accumulation of data to set performance and cost standards. Since the test drilling program is set up on the same basis of measurement as the mine production drilling, we would prove to the mine department exactly what the drilling equipment could do.

We realize that test work results will never be reached by production results because test work is done under more ideal conditions by experienced help. However, the test results show what can be accomplished, and if we can help the production units come closer to this goal by supplying better equipment, then a major part of our job is accomplished.

How Data Is Gathered on Production Drilling Equipment

It would now be worthwhile to show the procedure used at Climax to get all the information together on the production drilling equipment and how it is condensed into the final reports on performance and costs.

A bit locker is maintained at the change room on both levels for storage of bits, couplings and bonus rods. At the start of the shift the bit checker fills out the following information on the "Daily Tungsten Carbide Bit Report" form: the miner's work number, string number, the number and kind of bits checked out and the working place. Also, if it is necessary to add new bits to the string, he shows how many were added and gives the reason as "Short" or "Boss." "Short" indicates that the bit sharpener has removed some bits from the string for which he had no replacements, and tags the string showing how many bits need to be added. "Boss" indicates the shifter or foreman has okayed new bits or extra bits because of the type of work the miner is doing. The checker also records at the start of the shift if the miner was given any bonus rods or couplings. It should be noted that only the bit checker adds new bits to the strings. This gives us good control over the issue of new bits.

When the miner checks out his bits at the start of the shift, he picks up a bit card. At the end of the shift, he fills out the card to show his work number, string number, footage drilled, working place and machine number. He also notes if any bits were lost or stuck in the hole.

The miner attaches this card to his string and turns it in to the bit checker at the end of the shift. The bit checker then completes his report from this data, recording the number of bits returned and noting if any were lost or stuck in the hole. He replaces these with new bits. He records the footage drilled and the number of the machine that was used.

Bits are picked up at the end of the shift and sent to the mine shop to be sharpened. The sharpener also fills out a daily report that shows the following information: the string number, the type and number of bits received, the number of bits removed from the string and the reason for removal, the number of bits actually sharpened, the number of used bits added and the number of bits returned to the bit locker. This report serves as a cross-check on the bit checker's report.

It should be explained here where the sharpener gets his used bits to add to the strings. One source is bits from which stubbed drill steel has been removed. The second source is by removal of extra or unused strings from the bit lockers.

The bit checker's and the bit grinder's daily reports are sent to the planning office. Here, all the information is transcribed by a clerk into the Bit Book. The pages, made up each month, are called "Contractor's Bit Sheet." All the data from the checker's report and the sharpener's report are consolidated onto one page.

The month's footage drilled on each level is totaled. Footage drilled with each type of bit can be determined as can the footage drilled by each machine.

Monthly performance of bits, couplings, and bonus rods is determined from this data. The planning department controls the inventories of these items in the two bit lockers and can easily determine the number of each of these items used during the previous month on each level.

It is a simple procedure to compute the performance of these items as average footage per bit, etc. This is done for the 1½-in., 1¾-in., and 2-in. bits, and for the bonus rods and couplings used on each level. Accumulative figures are kept on all these items for immediate comparison.

Unit cost is computed with equal simplicity. The purchase price of each bit is known and therefore total purchase cost of all bits on each level is easily determined. The cost of checking and sharpening, including labor and grinding wheels, is included. These two figures give the grand total cost of bits on each level. Footage on each level is known, so the bit cost per foot of hole can easily be determined.

Determining the unit cost of rock drills is somewhat more lengthy, but still essentially simple. The cost of rock drills for the monthly report is confined to maintenance and repair only. The purchase cost is not considered in the monthly report.

All machines are stamped with a shop number. The drill doctor keeps a record card on each machine according to this shop number. As each machine is repaired, the drill doctor notes the new parts used and the time required for repair. At the end of the month, the test engineer transcribes the data on these cards to an identical file kept in the planning office. From current price lists, he obtains the cost of parts put in each machine repaired that month. He computes the labor cost from the time required to make repairs. From the Bit Book he obtains the footage drilled by each machine used that month. He then can determine the total repair cost for each machine. Knowing the total footage drilled by each class of machine, he can determine the cost per foot of hole for the past month for each type. Total repair costs and total footage give the over-all cost per foot of hole for all machines on both levels.

Correlation of Test and Operational Data

It was previously discussed in some detail how the test program was set up at Climax and the purposes for which it was started. The two main purposes were:

(1) Development of better drilling equipment.
(2) Establishing standards of performance and cost for drilling equipment.

While these two purposes are very valuable in themselves, another major benefit is in the comparison of test work results to production results. Test results take on much value when compared to the results the production units obtain from identical equipment.

With cost and performance reports on production drilling equipment being compiled monthly, and test data being collected continually on some part of the drilling equipment, we have current figures for comparison and correlation of test results to mine performance. When the need arises, detailed reports or analyses may be compiled quickly to give a more complete picture of any particular detail of the drilling problem.

The correlation between these two results is brought to management's attention primarily by two methods:

(1) A summary discussion of the month's work attached to the monthly data reports of cost and performance.
(2) A special report — submitted either when we believe it is needed, or when management requests it on some particular point.

Normally, the correlation of test and production figures is made known to the supervisors through discussions with them, and on important results, a written report is submitted.

The benefits to Climax of this correlation of test results to production results are:

(1) Being able to take advantage more quickly of using test-proven equipment that is superior to equipment in current use.
(2) Locating more quickly any trouble spots in the production equipment.
(3) Being able to act more quickly to eliminate these trouble spots.
(4) The combination of the above three steps tends to decrease high costs—a major benefit to be gained by the standardization program.

Benefits Individual Operator

A majority of the larger mining companies now utilize some sort of research or testing department to check the performance and costs of all kinds of mining equipment. The number of men employed in this work varies from one to as many as 20 at each property.

Maintaining these departments involves a considerable expense to the individual operator. This expense is justified only if the testing and research leads to improved methods and equipment which in turn mean lower costs. If these objectives are not accomplished, then the expense of maintaining such a department is not justified. The primary purpose of these departments is to cut costs.

At present most test departments operate individually with only a minimum of information exchanged between these departments of different companies. What this means is that we are each duplicating the other's work to achieve the same goal. Each individual operation tests each individual machine, or drill steel or bit. While this is necessary to some degree, due to unique problems existing at individual properties, there is still excessive duplication and repetition of effort. A common meeting ground brought about by the standardization of measurements, and a freer exchange of this information between the individual operators, would be of tremendous benefit to all.

How many times have we discovered that a poor decision could have been avoided by getting information from some other operation that had previously faced the same problem?

No one company has all the answers to drilling problems. We are all looking for improvements. It is a slow, costly road to progress for mining companies to go on testing singly without knowing what advances are being made by others in similar work.

The data amassed by the research departments on drilling problems over the past 30 years comprises a gigantic wealth of knowledge. It is time that this information be based on standard measurements and made useful and accessible to all mining companies. Mining companies should be able to rely on one another for accurate information without having to seek it from third parties.

If Climax obtains drilling equipment cost figures from a company that bases costs on "cost per cubic foot" or "cost per ton," there is no sure way of relating them to our costs. An accurate comparison just doesn't exist. It would be possible for all other companies to use "cost per foot of hole" figures.

Therefore, we believe it most important that all mining companies adopt this same standard of measurement, and have it form a common basis for unit cost and performance. Then it

(Continued on page 79)

Typical longhole drilling setup in undercut

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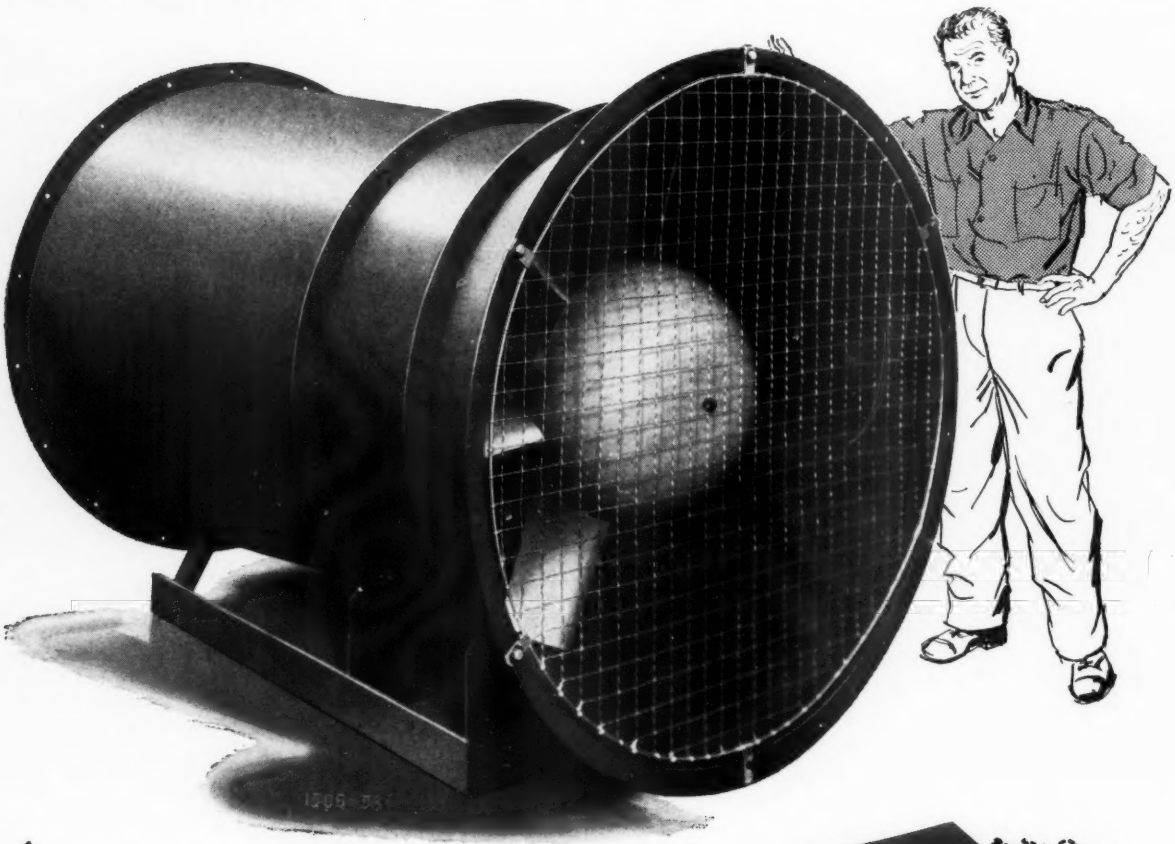

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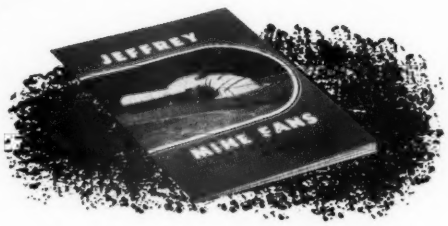

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Work simplification is a basic procedure in industrial engineering for studying a single operation or a whole process, analytically from all points of view

Industrial Engineering And Coal Mining

A qualified author outlines some of the industrial engineering procedures that may be applied to the coal industry and shows how one company has utilized this science

By JOHN H. GOOCH
Management Consultant
Ingle Coal Co.

RECOGNIZING that the field of industrial engineering is a big and complex subject, here are a few suggestions which you may care to follow in making further investigation for your industry.

(1) Define your industry problems of today as accurately as possible and write down several of them, perhaps five or ten of the more important coal mining problems which you recognize today. This is desirable in order to find a reasonable starting point.

(2) Paint yourself a picture of four or five real goals toward which the coal industry should be striving today. Use your imagination vividly and select things which you would really like to have in your industry. This picture impressed upon your mind will be a real influence in changing the situation to what it should be. A description of these pictures can stand as much analysis and synthesis and artistic achievement as the most elaborate coal mining machine has received.

(3) Study some of the industrial engineering procedures. Use books such as Time and Motion Study by Lowry, Maynard, and Stegemerten, hand books such as the Production Handbook or an industrial engineering handbook, magazines, such as Factory Management and Maintenance. Attend meetings of the societies, The American Management Association, New York; The Society for the Advancement of Management, also in New York; the Industrial Management Society, Chicago; or the American Institute of Industrial Engineers.

(4) Learn what other industries have been doing with industrial engineering. Many of them have been doing a great deal and you will probably be fascinated by some of their stories.

(5) Conduct some experiments with industrial engineering procedures on specific problems in some of your mines. You may need a committee of from 5 to 25 people to carry out such a program. Each one of your companies is almost certain to benefit greatly from industrial engineering. A good plan would be to select some member in your organization who is mathematical, analytical and friendly and have him start devoting from ¼ to ½ of his time to industrial engineering procedures with the object of solving problems, providing information, helping guide the company's destiny and making everyone in the organization happier.

Review of Preliminary Procedure

In selecting and describing the main problems, your engineer may be considering such things as increased coal production, cost reduction, preventive maintenance, repairing machinery breakdown, coordination of the various machines in the mining process, orderliness at all parts of the enterprise and the development of a good organization. For goals you might select the figure which would represent your dream of daily production per man or state the profit which you think would be reasonable for you to make on each ton.

A good industrial engineering procedure on which to start would be work simplification. Select some operation or some process, learn every detail about how it is done, and then question many of these details using a special set of questions: mainly based on who, what, where, when, why and how. As an experiment, select one of the simplest operations you can find and apply several of the industrial engineering procedures to it. Some examples are: the taping of an electrical connection with asbestos and rubber, removing a cover plate from a machine, repairing a cable, or for a bigger job, laying a switch. You might also examine and reappraise what has been done in the field of mechanization for the mines which really seems to be an outstanding example of what is called industrial engineering. At this point other industries should be coming to your industry to learn how to do industrial engineering. The new mine machinery has affected time, motions, costs, working conditions and human relations.

Study at Ingle Coal Co.

You may wish to know something about the work done at the Ditney Hill Mine, Elberfield, Ind., owned by the Ingle Coal Co. The work started there in January and the time has been too short to have any striking improvements.

The supply room had just grown and it was difficult to provide the needed repair parts quickly. One man could not make all the changes by himself and it was necessary to have concerted action by a group. Obsolete parts, equipment and scrap materials, even up to big items of equipment which had been stored in the supply room, were gradually moved out and sold or stored some place else. This opened up the aisles and made more room to store material which was current. The parts for each of several of the machines used in the mine were stored in various parts of the supply room. Some revolving tiers of circular bins were purchased in order to have a large number of storage compartments close together and make it possible to store all of the parts for one machine in approximately the same place.

Naturally there would be too many of little used parts and too few or none at all of the parts which wear rapidly and are needed more often. A start was made toward studying the parts to determine which ones needed to be in stock and how many needed to be on hand. A list was made of the parts for each machine which wear out more rapidly in order to concentrate for better service on them. The lighter and less used material was moved to the second floor in order to make more room for the important parts in the favored location.

The president, David Ingle, Jr., encouraged the others to make immediate improvements; the general manager, Alva Harris, arranged for disposal of the obsolete materials and prepared the list of parts which wear rapidly; the purchasing agent, Bradford Ingle, planned the rearrangement of the supply room. The shop foreman and the night supply man contributed what they knew the supply room needed. This group began to operate as a kind of cost reduction or methods improvement committee.

The machines in the mine were having a number of breakdowns and reducing coal production. The maintenance records for these machines for a five-week period were analyzed and the breakdowns on each machine were listed separately, then classified according to the kind of breakdown. When the frequency on each breakdown was known and the amount of time lost, it was easy to pick out the problems which needed attention first. A loading machine had controller trouble, a new part was bought and the trouble stopped. A shuttle car had many cable repairs. When the management, boss and operator knew the situation, this problem was greatly reduced. In all cases the men as well as the bosses were quick to cooperate when they understood the situation.

The analysis of maintenance records showed three problems. A certain amount of time was recorded as lost to production while certain repairs were being made on the machines. There were many other breakdowns for which no time was recorded as lost because substitute machines were used, but it was easy to guess that smaller amounts of time were frequently lost in this way while the operators changed machines and did other routine tasks connected with such a breakdown. The substitute machines generally did not have the capacity or the power of the regular machines, and production was also lost by using them.

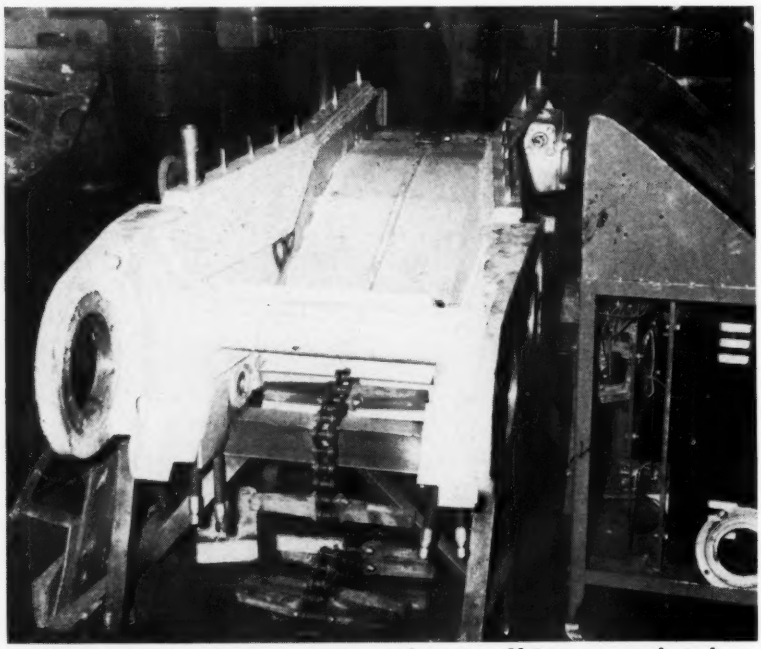
It also appeared that many of the breakdowns requiring a number of hours for repairs to be completed should have been finished much more quickly. The breakdown of machines in the mine was also related to the method of overhauling this equipment in the shop. Shop methods became a source of changes for increasing the coal production and the subject of preventive maintenance became important. The maintenance records that were studied showed some machines having one or more breakdowns day after day, but the present records indicate some of these machines operating day after day without a breakdown.

At the end of the day when the mine bosses sat around a large table, writing their reports, the general manager sometimes discussed with them some of the things which had been learned from the analysis of the maintenance records. They learned what was being done and which problems seemed the greater; then took steps to improve the situation. This amounted to another cost reduction or methods improvement committee.

Time study includes the one difficult technique known as rating the activity of the operator. This means comparing the work pace with a normal or comfortable work pace that is called 100. It is based upon pure judgment and is somewhat difficult

n the shop, cost data was needed and the time required for overhauling the mining machines needed to be reduced to increase production. A kind of time study was made, running over a period of several weeks, with the stop watch times recorded frequently, generally from one to five times per minute, and a record made as completely as possible showing what one, two or three men were doing as they overhauled a given machine. Suggestions for improvement made by the mechanics and other possible improvements that came to mind were also noted.

The mechanics in the shop were walking too much. The room was about 50 by 60 ft and the welding apparatus, benches, tool collections, grinders, forge, saw, drill and other equipment was stored mainly around the walls. As the men worked on any machine, they had to walk to all these



Efficient work place layouts save time and money. Maintenance needs to be planned thoroughly because it now more or less determines the production

places from time to time to get what they needed. Plans are being made to make one or several racks on wheels which will be specially prepared to hold what is needed such as the tools to be used on a given job, the parts taken off and put back on, scrap to be thrown away, and any special equipment. Nearly everything in the way of parts and equipment has been kept on the floor and this constant bending down wears a person out. The special racks being considered will help to relieve this situation.

The hoist being used is quite slow and the men are carrying too much material around. Some good suggestions have been made to correct this. When two or three men work together, one of them often has to wait on another and some planning will be needed to prevent this waste of time. Too many trips were being made to the supply room and the modernization of that section will bring the parts out quickly when needed.

Plans for Improvement

Plans have been made to rapair the concrete floor where it has been broken up in several points. The general manager had a meeting with the shop foreman and all of the mechanics in which about 25 suggestions already made were discussed more or less thoroughly. Additional suggestions were made and some plans were started. Mechanics mentioned tool shortages, make shift tools, the lighting problem, and several other things. After the committee meeting one of the men made an extensive suggestion for the installation of some comparatively simple equipment which might reduce the cost of repairing mine cars by about half. He had the whole plan worked out and it sounded quite reasonable.

The bosses and maintenance men kept mentioning some of the problems inside the mine and observations were made while the machinery was in action. There were quite a number of situations in which the crew of men in one unit were not fully coordinated. There were misunderstandings, short delays because an operation had not been completed elsewhere, one man waiting on another, a machine delayed because the next work place was not quite ready and a few neglected things which needed attention. Some equipment was not available when needed several times and some repairs did not get made fast enough.

This machinery has been developed so far that it sometimes seems that this may be the part of the mining operation which needs attention the least, but there is one basic situation which seems to need to be changed. The mining machinery is so efficient that it sometimes runs ahead of the rest of the organization and the pressure gets applied in the wrong direction. In this way the man operating the machines wait a little too long for maintenance in the mine, the mine maintenance waits a little long for help from the shop and the shop waits for help from the supply room.

This pressure may be changed so that the supply room is pushing parts to the shop a little ahead of the time when they are needed, the shop will be applying preventive maintenance to reduce the maintenance needed in the mine and the mine maintenance men will be anticipating trouble at the mining machines. Several of the changes needed here have already been started by checking on the time required for specific activities.

Some steps have been taken to divide the various responsibilities more equitably among the members of the organization in order to distribute the work load and to have the responsibility located at the right place. Daily production records were analyzed in order to determine the effect of some of the delays in production on the total volume. A small beginning has been made toward setting up a procedure for establishing standard times or standard costs for some of the more common operations. To do this the present method should be observed and an improved method should be prepared and then the improved method should be timed.

Shops and Supply Room Rearranged

An industrial engineer would be sure to see some great possibilities for the future. Many of the employes keep presenting problems that need to be solved and nearly all the employes are anxious to help the company solve them. This indicates that when the right kind of procedure or system is established and everyone becomes familiar with it there should be some great accomplishments by the mining companies. There are many pieces of equipment and material laying around in various places in a disorderly manner. Putting all these things in order, which may take a year or two has great possibilities for improving all the activities at the mine.

The supply room will be rearranged until good inventory control is secured with the maximum number of parts on hand when needed and with parts being delivered to the shop or

the mine in the minimum amount of time. The amount of investment in stock should be reduced and there should be considerable reduction in the waste of materials. The mantenance reports on the mine machinery will keep showing an improvement toward a minimum in the number of machine breakdowns that occur and in the amount of time necessary to repair them. Preventive maintenance will be applied with a careful study of the past record of each machine and with proper lubrication.

In the shop nearly everything will be changed in a steady progression toward easier work and more effective activities. The goal will probably be to handle the repairs and overhaul machinery with the same elaborate precision which is now in evidence in the operation of the machines used to mine the coal. The maintenance needs to be planned thoroughly because it now more or less determines the production. In one industry the basic cost dropped from 27c to 34c down to from 18c to 23c, when the program was less than half carried out. In another industry the cost of one of the products over a couple of years' time dropped from 66c to about 35c.

The operation of the shop as it is improved may in a similar manner be expected to drop from 30 to 50 per cent for a given amount of work. In effect it may mean that the shop will do a great deal more work without any increase in cost and this means about the same for the improvement will be felt in the production of coal. At present the maintenance men in the shop and in the mine do not have time to do some of the work which is needed. Work simplification will eliminate some of the waste and give them the time which they need, both for the present work and for the additional work of checking the machines to prevent breakdowns. Wherever the maintenance work is done efficient work place layouts will be provided, distances will be shortened, more efficient equipment will be provided, and idle time will be eliminated.

Some of the Industrial Engineering Procedures

Various industrial engineering procedures may be applied to the great field of mechanization as outlined in the following:

Orderliness: In a sense complete orderliness applied everywhere from all points of view sums up the whole story of industrial engineering. Management is an art and like painting and music must be orderly. Industrial engineering keeps making some part or other of a business more orderly.

Creativity: There is now a vast procedure in industrial engineering for studying a single operation or a whole process, analytically from all points of view.

Each company should have some kind of a training program. Everything grows more complicated and changes faster and the company needs to have each employe informed in the right way about everything

Office work simplification: This whole analytical procedure is being applied to clerical activities just the same as to the main productive work. One company has a conveyor for paper work.

Motion and time study: The consideration of space or motion and time is one of the basic concepts of the whole field. Every time one minute goes by you want the right materials in the right quantity to move a reasonable distance. Time study includes the one difficult technique known as rating the activity of the operator. This means comparing the work pace with a normal or comfortable work pace that is called 100. It is based upon pure judgment and is somewhat difficult. There are a dozen or more things to consider when taking a time study.

Budgeting executive time: The things that executives do are more important in their influence on the business than the activities of anyone else. The industrial engineer will help you transfer your routine activities to someone else and leave you more time for creative activities.

Cost reduction: This is another basic subject and it requires some time spent in getting organized, a manual of procedure and an analysis of the business from about ten different points of view.

Personal efficiency: Separately from the budgeting of executive time there is a whole group of things which an individual may do to make his own activities much more productive. Donald Laird has a book, "The Technique of Getting Things Done."

Work sampling: Sometimes you want to know what goes on all day at several points and how the time is divided but are unable to send someone there to observe all day. Separate observations at regular intervals are used to secure this information for the whole group at the same time in a relatively short total period.

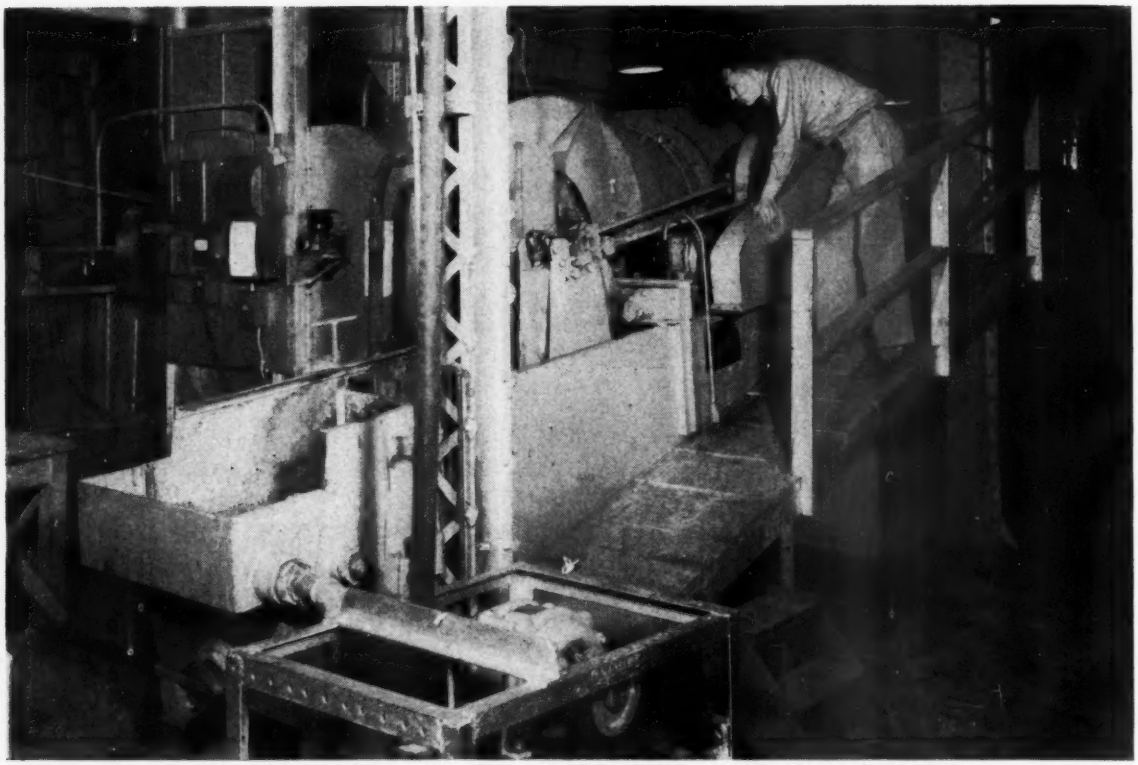
Preventive maintenance: It is so difficult for all of us to learn that a stitch in time saves nine. Industry in this country is so big that it justifies almost any amount of investigation.

Cost accounting: Having accurate cost figures, checking them regularly and doing the things indicated by the figures constitute a fine procedure. The results of the analysis must be expressed in terms that the mine boss understands well.

Industrial sociology: A book has been written on this subject and experience has shown that the way groups of people deal with each other can be the very biggest thing of all. This is an engineering approach in an attempt to help people handle their relationships with other groups in the right way to save time and prevent friction.

Non-financial incentives: Money incentives are well known but there are a number of other things which can be done to make workers feel more like producing for the company. They can be treated as individuals. Some of the places where they need help can be taken care of, and other things can be done for them. When changes are to be made which affect the employe, one of the biggest things that the company can do is to consult the employe before making the change in order to find out what the employe thinks about it. Management sometimes questions this procedure but when the employe is considerably affected, he feels far better when he knows what is coming in

(Continued on page 71)



A portion of the ore dressing pilot plant at the Colorado School of Mines Research Foundation

Solvent Extraction

This, the first of several articles on Solvent Extraction to be brought to our readers, gives the basic principles of the process. From an academic standpoint it points out the differences and similarities between solvent extraction and ion exchange and gives an indication of the problems entailed along with future possibilities. Later articles will cover installations where these principles are being put into practice

By E. H. CRABTREE and C. J. LEWIS
Colorado School of Mines Research Foundation, Inc.

REFERENCES to solvent extraction have appeared over a period of many years. These earlier references pertain to such developments as the use of solvents to remove materials from petroleum refinery intermediates, or to recover materials which are preferentially soluble in one or the other of two immiscible liquids. For example, certain water-borne fats which are highly soluble in chloroform may be extracted into a chloroform phase by agitating a mixture of the water-chloroform system, and then allowing the layers to separate before decantation. To mention an even more classic example, the preferential solvent action of carbon tetrachloride will extract the halogens, such as iodine, from their water solutions.

However, solvent extraction, as applied to the winning of metals, is a much more recent field, and, as applied to metals recovery, the use of the term "solvent" is at least a misnomer, if not misleading.

Terminology Clarified

Researchers at Oak Ridge, reporting on an investigation of the recovery of Uranium by contacting a Uranium pregnant aqueous solution with an organic, referred to this process as a cationic interface liquid-liquid extraction. It may be said that the expression "liquid-liquid extraction" is more accurate than the expression of "solvent extraction" as applied to the winning of metals, and that the use of the terminology "liquid-liquid extraction" in this field is gradually being generally adopted. For actually, the reaction mechanism involved when Uranium, Vanadium, Thorium, Yttrium and the like, leave an aqueous phase to associate with an organic extractant is not a simple dissolving

or solvent action at all, but instead this reaction mechanism involves ion exchange or, at least, ion migration.

In our many and varied investigations in the field of liquid-liquid extraction, it has been found helpful to utilize a working theory based on the similarity of the mechanisms of ion exchange and solvent extraction.

Solvent extraction, or liquid-liquid extraction, may be considered as simply an ion exchange between two immiscible phases. From this point of view many parallels and comparisons between this relatively youthful solvent extraction tool, and the much older, more fully developed technology of the ion exchange resins may be drawn.

This comparison is illustrated in Figure I; Item A depicts a cation exchange resin exchanging its active positive ion with metal ions or positive metal complexes.

Item B illustrates a kerosene soluble cation exchange organic compound also exchanging its active positive group with metal ions or positive metal complexes. It should be borne in mind that Item A refers to a solid state ion exchange resin, whereas Item B. refers to a material which performs a similar function, but in the liquid state.

Likewise, in Figure 2, Item A illustrates an anion exchange resin (in this case with an active negative group) exchanging with native groupings such as the molybdate ion, and the negative uranyl complex.

Finally, Item B illustrates a kerosene soluble anion exchange organic compound likewise exchanging negative groupings. The great similarity between the reactions involving the solid state resin and the liquid state organic may be noted. It might be more appropriate to refer to these anion exchange materials as ion engagers rather than ion exchangers if concerned only with Uranium, which exhibits a complex equilibrium among $SO_4^{=}$, HSO_4^{-}, $UO_2(SO_4)$, $UO_2(SO_4)_2^{=}$, $UO_2(SO_4)_3^{=}$ and UO_2^{++} in acid solutions.

Solvent Extraction and Ion Exchange Compared

As stated before, these comparisons are useful in solvent extraction studies. The technology of solvent extraction has very much in common with that of the ion exchange resin. Among these are such phenomena as the behavior of ferrous and ferric ions, the effect of oxidation-reduction potential, the behavior of molybdenum and vanadium in different valance states, the predictability of preferential loadings and the almost overwhelming effect of pH on both systems.

Such comparisons as indicated render it less difficult to appreciate some of the fundamental differences between the technology of the ion exchange resin, and that of the liquid extractant. For, it must be borne in mind that the present high interest in the application of solvent extraction to metallurgy had its origin as recently as mid-1955, when the AEC declassified a great mass of previously restricted information on this subject. Researchers need a familiar yardstick against which to measure this new technology. The ion exchange comparison offers a starting point.

The use of the liquid organic ion exchanger requires that this material be solubilized and carried in a third and water immiscible component, which is commonly kerosene. Such component is referred to as the "carrier" and its presence in the solvent extraction system immediately contrasts with the two component aqueous solution-solid resin system. The presence of the carrier begets problems and possibilities of a challenging nature to this new field; for, from a technical point of view, we are by no means limited to kerosene as the carrier, the choice of which serves as a highly interesting focus for research and development. Likewise, solvent extraction technology involves liquid mechanics to an extent far, far beyond those of the ion exchange resin system. Such items as the best mixing procedures to obtain intimate contact between the liquid phases, and the relationship between compounds present, concentrations, flow rates and emulsion formation must be resolved. Indeed, in one investigation it was found that agitator design was critical

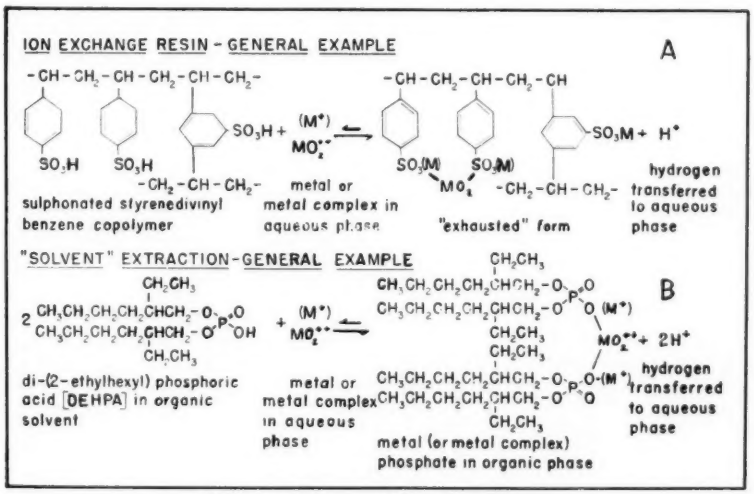


Figure 1—Cation exchange mechanisms

About the Authors

E. H. Crabtree

C. J. Lewis

EDWIN H. CRABTREE, a graduate of the Colorado School of Mines, has a background of over 26 years in various phases of the mining and metallurgical industries. He worked 19 years for the Eagle Picher Co., and was the company's director of milling at Miami, Okla., from 1947 to 1952. From May 1954, to August 1955, Crabtree was deputy manager, Grand Junction Operations Office, U. S. Atomic Energy Commission. He assumed his present position as director of the Colorado School of Mines Research Foundation on August 1, 1955 where he is engaged in directing the widespread research activities of this institution in the development of chemical and mineral dressing processes for the treatment of ores.

CLIFFORD J. LEWIS is a graduate of Pennsylvania State University in chemistry and of the University of Pittsburgh in metallurgical engineering, and has a background of over 20 years of experience in various phases of the chemical and metal industries, particularly in the fields of research and process development.

From 1945 to 1952 Lewis was technical director of the Warner Co. of Philadelphia, Pa. Before joining the staff of the Colorado School of Mines Research Foundation, he was a senior fellow at the Mellon Institute of Industrial Research, Pittsburgh, Pa. He is now in charge of chemical research and the analytical laboratories at the Foundation. He has authored many publications, particularly in the field of water pollution abatement.

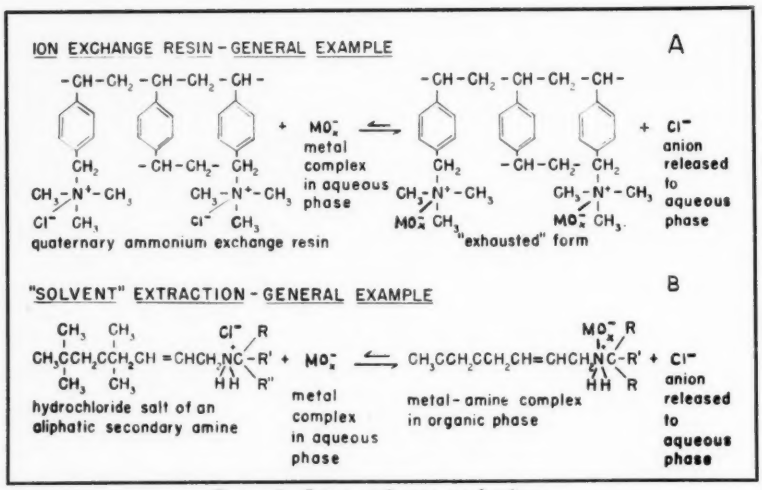


Figure 2—Anion exchange mechanisms

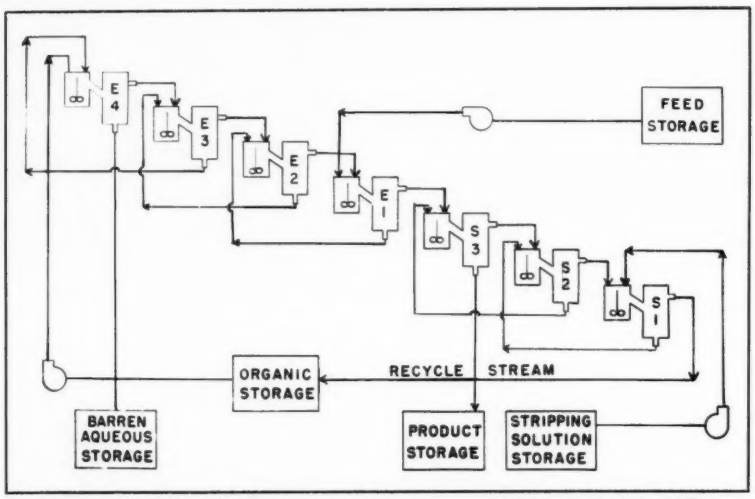


Figure 3—Four stage laboratory solvent extraction unit, Colorado School of Mines Research Foundation

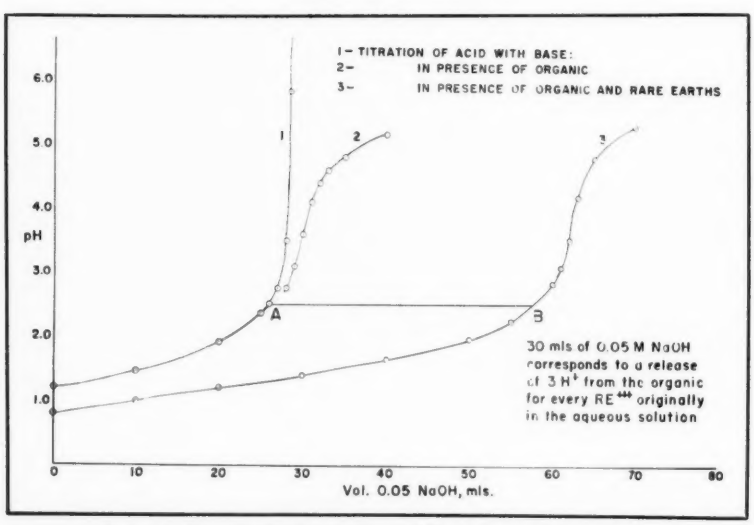


Figure 4—Titration gives a measure of the ion exchange occurring

to emulsion prevention, and that by a minor modification in agitator design, the extraction stages could be reduced from six to four without loss of extraction efficiency.

Unloading

Finally, in the unloading of the organic of the solvent extraction process, to regenerate this material for reuse, and obtain the aqueous concentrate, there are factors involved which contrast sharply with the parallel step in the ion exchange resin process. The unloading of the ion exchange resin is referred to as "elution," whereas this same step in the solvent extraction procedure is commonly referred to as "stripping." For example, it would be disastrous to attempt precipitation in an ion exchange column simultaneously with elution, or at any time, for that matter. Yet the versatility of the solvent extraction process is such that stripping may occur concurrently with precipitation, with precipitate following the aqueous concentrate, while the regenerated organic is being recycled in its carrier.

Figure 3 illustrates a continuous solvent extraction flow sheet. It can be noted that the organic phase flows counter-current to the metal pregnant aqueous phase during the loading cycle, and likewise during the stripping cycle. The number of mixer settlers may be varied as desired, and flow rates and feed concentrations are fully controllable.

Fundamental Research

Solvent extraction studies at the Foundation have so far been primarily concerned with the development of fundamental knowledge, as well as processes, pertaining to Uranium recovery. However, solvent extraction investigations have also been undertaken on the recovery of Thorium, Vanadium, Molybdenum, Copper, Zinc and Yttrium. A set of curves developed during solvent extraction studies on Rare Earth separation may be shown. These are illustrated in Figure 4. In this case, it was desired to verify an equilibrium at pH 2.5 between a heptane soluble cation exchange organic and an aqueous solution of certain rare earths. The active hydrogen of the organic exchanged into the aqueous phase. The increase in hydrogen ion, of course, added to the acidity of the aqueous phase and this increase in acidity, which could be determined by titration with standard base, was taken as a measure of the ion exchange occurring.

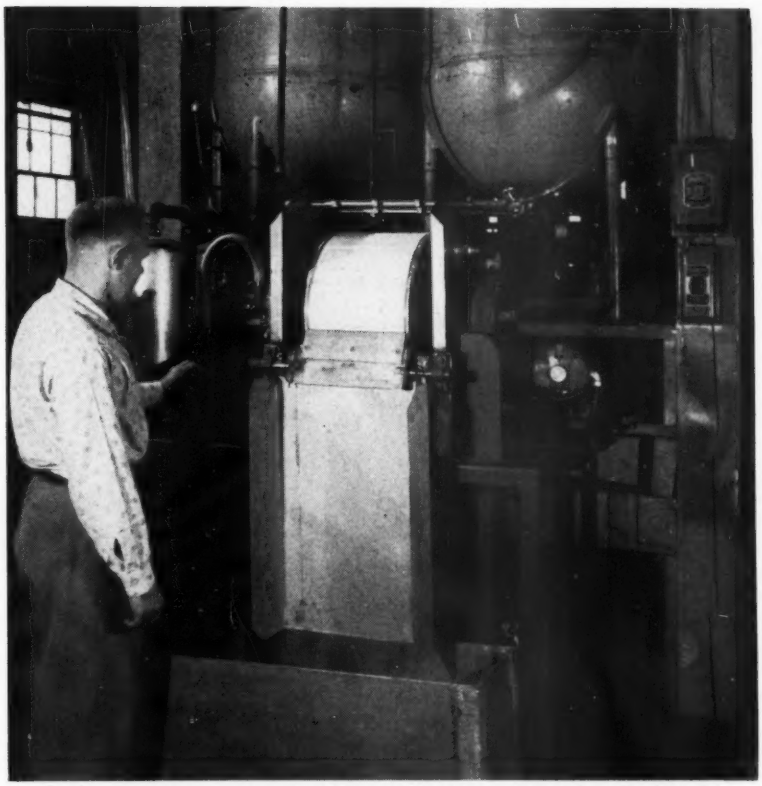
Curve 1 illustrates the titration of a standardized acid with a standardized base.

Curve 2 depicts a similar titration, but after a quantity of the cation exchange organic had been agitated with the acid and allowed to separate.

Curve 3 shows the titration of the

acid to which rare earths had been added before the acid was agitated with and separated from the cation exchange organic. The linear distance between points A and B is a measure of the increase in hydrogen ion released into the aqueous phase as the equivalent amount of rare earth entered the organic phase.

A considerable amount of investigational work on the effect of such carriers as benzene, xylene, toluene and heptane, in addition to kerosene, has been undertaken at the Foundation. One interesting development along this line occurred when using a particular Uranium pregnant solution, rich in molybdenum. When using a mixture of 2-diethylhexyl phosphoric acid in heptane, it was not found possible to strip the molybdenum from the organic phase, although no difficulties along this line were encountered when the carrier was changed back to kerosene. It should be noted that just as Uranium may be loaded onto both anionic and cationic ion exchange resins, Uranium can be solvent extracted by using both anionic and cationic kerosene soluble organics. This permits a dual approach to the solvent extraction of Uranium.

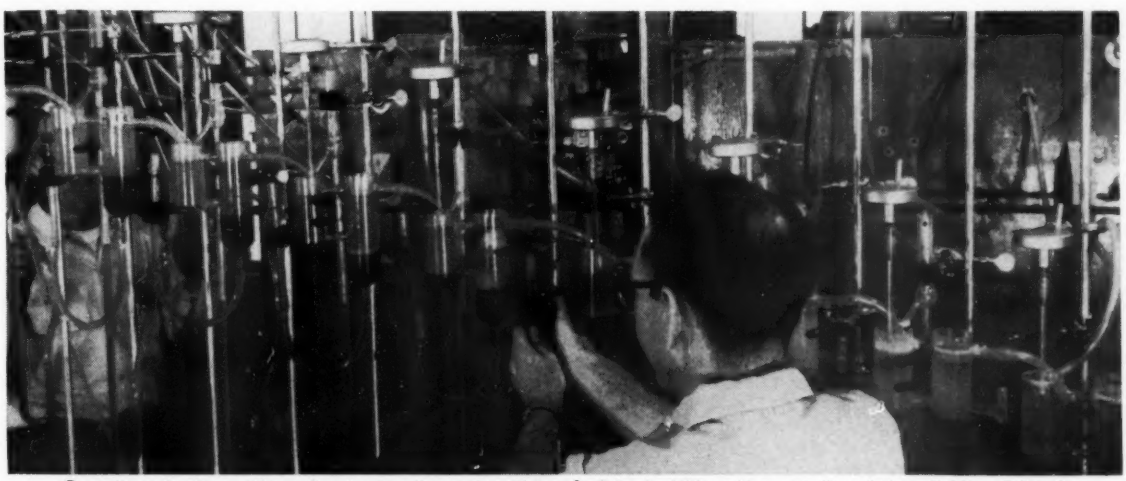


Stainless steel filter equipment of the acid leaching pilot plant at the Colorado School of Mines Research Foundation

Outlook

The foregoing remarks attempt to cover some of the broad potentialities of solvent extraction, without attempting to be specific as to any particular solvent, carrier or process conditions. The close similarity between ion exchange resin and liquid organic in carrier has been illustrated. Evaluation of the technical advantages, or disadvantages, of the ion exchange resin technique, as compared with solvent extraction technology has been avoided. It is believed too early to make such evaluation. An enlightening comparison dealing particularly with the potential economics of these two processes may be found in an article entitled "An Ore on the Plateau," which appears in the June 18, 1956, issue of C & E News.

It can be pointed out that the ion exchange process is used in practically all of the major Uranium mills today, and that it is apparently still favored in the design of mills currently being constructed, or presently planned. However, laboratory research on solvent extraction processes appears to be rapidly overtaking that on the ion exchange resins. There appears to be considerable anticipation of the development of a process for the direct solvent extraction of Uranium from pulp systems from the leaching vats, thereby bypassing the clarification step. Likewise, the increasing interest in the application of solvent extraction to the winning of metals other than uranium may be noted.



Operation of mixer-settler solvent extraction units—Colorado School of Mines Research Foundation, Golden, Colorado

The right to work, whether a man belongs to a union or not, is a basic right

Labor Relations and States' Rights

By BARRY GOLDWATER
United States Senator from Arizona

THE concept of the Right to Work is based upon two premises, the first of which is the Freedom of the Individual, and the second of which is the Right of Association.

Let's explore, first, the Freedom of the Individual. Right to Work laws are Civil Liberties measures. As more and more employers in our country signed agreements with the Unions for closed shop clauses, it becomes evident that, with such arbitrary powers placed in the hands of the Unions, a man's membership in a Union was becoming more important than his rights as a citizen, because his livelihood depended upon maintaining this membership. The emergence of this fact created an interest among the very workers affected in the States that have enacted these laws, to the extent that their passage was possible.

The best expression I have read concerning the freedom of the individual was that by Bennett B. Patterson in his book, THE FORGOTTEN NINTH AMENDMENT. He said: "Individual freedom and the recognition and development of the spiritual nature of mankind are the essence of democracy. Indeed, they are the essence of life itself. We believe that, by nurturing and encouraging the natural development of the individual to the point that he will achieve his greatest work, society as a whole will profit in the greatest measure."

Our whole system of Government and our whole system of Enterprise is based upon individual rights and freedoms. Our basic writings abound with references to these principles, and we need only to look at the Declaration of Independence to find the substance of all our liberties—"We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain inalienable rights, and, among these are life, liberty, and the pursuit of happiness." That is not only the cornerstone of our Republic, an expression of our freedom as stemming from God; it actually spells out our fundamental rights as citizens. The Right to Work is one of these freedoms. It is fundamental. Without it, a man cannot retain the right of liberty, or the right to pursue happiness, for both are dependent upon his right to work.

For years, those people who now travel deceitfully under the name of "Liberal" have been stating that the "right to a job" is one of the basic human rights; and they go further to say that our Government is not only *bound* to protect this right to a job, but must also, if necessary, create it. These same pseudo-liberals are highly concerned today because 17 States have passed legislation, or included provisions in their Constitutions, to protect workers from being deprived of their jobs by reason of membership, or non-membership, in a Union.

The question which is raised at this point is this: Is the right to a job really a basic human right, or is this right restricted to union members only? Actually, there is no inherent right to a job in this country or in any other country that follows our concept of freedom. A person certainly has the right to seek a job but to assume that a job is a right would be a material approach instead of the spiritual one that has always activated our people.

Our Constitutional Rights

The right to a job exists only in man's determination to get a job, and to keep a job. If there are rights connected with that, then those rights are wrapped up in expressions of the Right to Work Laws, which recognize that the right to work, whether a man belongs to a Union or not, is a basic right, expressed in our Declaration of Independence, and further outlined in various places in our Constitution.

The right to work is co-extensive with the right to life itself. Shakespeare said something about this; and, while Shakespeare was no Labor-Management Relations expert, his philosophy, nevertheless, certainly can be applied. In "The Merchant of Venice," he wrote: "You take my house when you take the prop that doth sustain my house. You take my life when you do take the means whereby I live." When a man must belong to a union to obtain or retain work, then that man does not have the right to work under our concept of freedom; and we, in effect, if we fail to recognize this, must bear the responsibility for Shakespear's charge ——"You take my life when you take the means whereby I live."

Let's look at the Constitution and see what it has to say on the subject of the right to work and the other rights which man enjoys in connection with employment. The oft-quoted Fifth Amendment of the Constitution says, in part, "No person shall be held to answer for a capital or otherwise infamous crime." Then, it goes on to list several other exemptions and says, "nor be deprived of life, liberty, or property without due process of law."

Certainly, if a man is forced to join a union in order to obtain or retain employment, that condition, being one of compulsion without due process of law, violates that part of the Fifth Amendment. Likewise, if a man were denied employment because of membership in a union, that condition, also, would be in violation of this Amendment. Quite similar language is contained in the Fourteenth Amendment which says, in part, "Nor shall any state deprive any person of life, liberty, or property without due process of law."

Thus, we see the clear intent of the Constitution to protect any right bearing upon life, liberty, and property; and the right to work is fundamental to these endowments. If a man is denied work by either non-membership or membership in a union, then he is deprived of these rights without due processes of law.

Inherent Freedom

There is another amendment, not often referred to by students of the Constitution, or generally recognized by the American public, but it contains what is to me one of the basic statements about our freedoms. The Ninth Amendment says: "The enumeration in the Constitution of certain rights shall not be construed to deny or disparage others retained by the people." When our Constitution was framed—in fact, when our first basic papers were written, after our forefathers began to think about our concept of freedom—it was understood and accepted as an immutable premise that our rights and freedoms were inherent because they came from God.

Our forebears did not believe it was necessary to outline in detailed form each and every one of these rights, and that is the reason why the Bill of Rights was not written when the Constitution was first presented. It was only after the framers of these documents came to realize that the time might come when there would be some doubt concerning these rights that they set them down in the first Ten Amendments to the Constitution. Believing them to be inherent by virtue of their Divine inspiration, the Constitution set out to protect these rights.

The Ninth Amendment is a broad statement of their protection and scope. It recognizes that the individual, and not the state or the Federal Government, is the source and the basis of our social comport. It recognizes that sovereignty rests with the individual. The Right to Work is a right that must be protected if the rights of life, liberty, and the pursuit of happiness are to be preserved in our country.

The Right of Association

After studying these laws for the past ten years and watching their operation, I have come to the conclusion that the Right of Association is probably the heart of the Right to Work movement. Assuming this, therefore, we should look at our Constitution to see what it has to say about this freedom. In the First Amendment, we find this expression, "Congress shall make no law respecting an establishment of religion." Then, it states, "Or the right of the people peaceably to assemble." Again, we get back to the freedom of the individual, for this right springs from the liberty of the individual to order his life as he sees fit; to choose where he will work, to choose his church, his political party, his lodge, his union—or, if he desires, to choose not to affiliate with any of these.

No law should compel any man to join, or condemn him for joining, any organization or group. Some men want to belong to unions; some do not. It is as simple as that. Yet, some union leaders want the right of assembly destroyed by the extension of compulsory unionism into states where that right is now protected. There are many reasons that would cause a man to hesitate in joining any organization, just as there are many compelling reasons that make men want to associate with others in the pursuit of common objectives. It is difficult to understand why there exists here in America, the land of the free, a desire on the part of some people to force men to join unions in order to gain and retain employment.

There are unions in other parts of the world, successful unions. There are countries that are far more unionized than the United States. So, in an effort to relate the success of unions in other parts of the world with those in our own country, I have studied a report from the International Labor Organizations.

Seven countries of the world have compulsory unionism in some form, but none of them have compulsion by law. The other countries prohibit it, except in rare cases; and in these instances, by collective agreement only. The most unionized countries in the world, the Scandinavian countries, prohibit compulsory unionism by law. It is simply not allowed. Yet, in spite of that, we find a greater percentage of the working people belonging to unions in those countries than in any other nations in the world. Universally, compulsory unionism is frowned upon. Leaders across the world recognize that, in compulsion, you also have the seeds of self-destruction; but allow a man the freedom to join, or not to join, and that individual who does become a union member, after exercising his free right to determine his choice, becomes a good union member, and an asset to his organization that can only add strength to his particular group.

The States' Rights Issue

In this discussion, and in any other discussion on the same subject, one is bound to be confronted with the issue of States' Rights. It has already been suggested that possibly the paramount issue before the American people today could be characterized by the question of just how much authority Government should exercise over our individual daily lives. If we are to reduce the constantly growing influence of the Federal Government upon our individual affairs, we must become more concerned with States' Rights; for the original intent of the Constitution under our Republican form of Government was to vest most of the power in the States themselves, with the thought that, because the States are closer to the people, they could best govern.

With this in mind, the author introduced, in 1953, in the 83rd Congress, an amendment which would return to the States their right to regulate and control striking, picketing, boycotts and lockouts. It was the

No law should compel any man to join, or condemn him for joining, any organization or group. Some men want to belong to unions; some do not

thought in presenting that amendment to the Senate that the matter of States' Rights is of infinitely greater significance than the Taft-Hartley Law, as such. Indeed, it is a concept which transcends all personality and all legislation, because it concerns the fundamental caliber of our thinking—our basic point of departure, from which evolve all of our legislative intentions and judicial interpretations.

The Constitution is crystal-clear in its intent that Government should remain close to the people. Yet, in recent years, we have seen more and more of a tendency to place government in the hands of Washington. In order that there be no misconception about the intent of the Constitution, allow me to recall a brief statement by Thomas Jefferson, made in 1823. He said: "I ask for no straining of words against the general government, nor yet, against the States. I believe that the States can best govern over home concerns, and the general Government over foreign ones. I wish, therefore, to see maintained, that wholesome distribution of powers established by the Constitution for the limitation of both, and never to see all offices transferred to Washington."

The Garner Case

In spite of the overwhelming evidence presented by the Constitution, and by the men who actually framed that great document, there are those in this country today who wish to deny that the intent is as expressed in the words of the Constitution and in the words of its framers. These people have been aided by decisions of the Supreme Court, one of which presents a more valid and vivid argument for the enactment of corrective legislation than any other one which I can present here today. That of course, is to the Garner Case, in which the decision rendered by the Supreme Court has, in effect, struck down all state labor laws, with the exception of those protected by Section 14(b) of the Taft-Hartley Act.

If the people of a sovereign state cannot adopt legislation to regulate strikes, picketing, boycotts, or lockouts, when these activities interfere with the daily lives of their citizens, then the people of that state have lost their sovereignty. The arguments for or against limiting or extending States' Rights in matters of labor are important, not only because of the subject, but also because revitalizing state and local governments, and recognizing that there is meaning and purpose behind the Tenth Amendment, is essential to the continuance of this Republic. For too long a period, the tendency has been to look toward Washington and to the Federal Government for the solution of problems that the Constitution clearly intended the state and local governments to solve.

Hearings were held during the 83rd Congress on suggestions directed toward the amending of the Taft-Hartley Act. Forty-three employer witnesses testified on the general question of the respective scope of Federal and State regulation of labor-management relations, only one of whom opposed giving the states greater power to regulate in this field, and a number of whom advocated leaving the matter entirely to state law, except in cases of national emergency. Five management spokesmen recommended that the Federal Government be removed from the field of industrial relations, except when the national welfare is endangered by emergencies and labor monopolies; but the majority favored merely giving the states greater power to act.

To this end, employers presented proposals, first, to allow the states to handle all subjects not covered by, or not in conflict with, the Federal law; second, to give the states power to control specific situations, such as misdemeanors, breaches of the peace, right to work, and sit-down strikes; and third, to give the states concurrent jurisdiction with the Federal Government where Federal Law should not supersede state law.

The majority of the other witnesses during these hearings—Federal and State Government officials, legislators and attorneys—endorsed the restoration of the jurisdiction to states in labor disputes. However, the eleven union witnesses who testified, and who discussed this general question, all favored having regulation of labor-relation matters remain exclusively under the authority of the Federal Government. These hearings were held before the decision of the Supreme Court on the Garner Case; and, had we had this decision prior to the hearings, I feel certain that the demand for state authority in these fields would have been even stronger than it was.

You will probably recall the Garner Case. It was one in which an injunction prohibiting picketing was obtained by the employer in the lower state court, on the ground that the picketing was in violation of the Penn-

sylvania Labor Relations Act—that is, the State Act. On appeal, the Pennsylvania Supreme Court reversed the decision of the lower state court, holding that the controversy fell within the jurisdiction of the NLRB, and that the State Court was powerless to grant injunctive relief. The Supreme Court of the United States upheld the State Supreme Court, stating, in substance, that State Courts are without jurisdiction in such cases.

Allow me to point out that situation that exists in some of the States today that will be gravely affected by this Supreme Court decision. Twenty-eight States of the country have labor laws on their statute books.

Fear and Confusion

It was impossible to obtain favorable committee consideration of the author's amendment during the 83rd Congress; so, when the amendments finally approved by the Committee to alter the Taft-Hartley Law came to the Floor, I took that occasion to introduce my amendment.

We had, before that Congress, as you will probably recall, two other States' Rights issues on which there was extreme activity, both for and against. The first of these was the Tidelands issue, and the second came on the Bricker Amendment. In the Tidelands case, States' Rights prevailed; but, in the case of the Bricker Amendment, the States' Rights principle was defeated by one vote.

My amendment being offered to the Taft-Hartley Act naturally caused those who were violently opposed to States' Rights, and who still are, to challenge it vociferously on the Floor of the Senate. This effort to restore to the states rights that have been taken away from them, rights that the Constitution intended them to have, had a sad ending.

The word "sad" is used because, when the motion was made to recommit the entire bill to the Committee, Senators from States who have, historically, been strong proponents of States' Rights found it necessary, for some unknown reason, to vote for this recommittal. The vote was 50 to 42 to recommit, and another effort to put meaning into the Tenth Amendment, and to put strength where it belongs —in the states—was defeated.

It was amazing to me, a Western Senator, to hear Senator after Senator from Southern States record their votes in favor of recommittal when the entire question hinged on States' Rights. For some time, this situation perplexed me, as I could not understand what was behind it. Of course, it was known that there were those who were conscientiously opposed to the rights of the states; and that there were others who did not like other provisions of the bill that came out of the Committee.

Some clarification for this ironic action can be found in the report of the Executive Council of the American Federation of Labor, wherein it is stated, on page 67: "We, therefore permitted the debate to continue for a couple of days, and then, Senators Ives and Lehman presented Fair Labor Practice Amendments. This, of course, put the Southern Senators on the spot because they were obliged to oppose this. It also did the same for the Republicans, who, as a Party, are supposed to favor the proposal. The A. F. of L. was opposed to a Fair Employment Practices Commission proposal being added to a Labor bill. We then made arrangements with Senator Hill to offer the motion to recommit before any amendments were voted on, and, as all factions were fearful, and more or less confused, they voted to recommit the bill, 50-42."

This incident is recounted in partial explanation of the defeat of my States' Rights proposal in the 83rd Congress, because it points up, in a most graphic way, the strength which Labor Unions have gained in at least one of the Committees of Congress. It should also serve as not the least of many warnings to all Americans that the liberties of this Republic are not unanimously endorsed or respected, and that the never-too-great price we must pay for our rights as free men is the constant and devoted exercise of these liberties, lest, by our indifference, we shall lose them.

How much central control should be placed in the hands of our Federal Government? Its authority must be balanced with that of the states and the individual citizens

Expanding Government

How much authority should Government exercise as a device for influencing our individual lives? In other words, how much strength do you want to put in Washington? How much do you want to keep for yourself and for the States? Do you want Washington to determine how you live? What you can and can't do? What businesses you engage in? How long your laborers can work, and what you must pay them? What you can raise on your farms, and what prices you will receive for those products?

The threat of an ever-expanding Federal Government is, to me, a far more serious threat than Communism; for we can and surely will—destroy ourselves if we continue to accept the theory that the Federal Government can do everything for us, instead of doing for us only those things that we cannot as well or better do for ourselves.

If the trend toward centralized Government is continued, and if the business and professional and laboring people of this country do not wake up to the threats involved, and act accordingly, as free men should, then I suggest that we will soon became "brainwashed" by the postulates of Socialism, and that the end result will be the same as if the Russian hordes had actually conquered us.

Who can deny that the abandonment of sacred rights and principles is the first and fatal step toward the abandonment of life itself?

A Petroleum Company Takes A Look At Uranium

The development of adequate reserves of fuels capable of producing atomic energy is considered from the viewpoint of a petroleum company that has committed itself to a future in uranium

By GERHARD HERZOG
Director of Research, The Texas Co.
Vice-President
Texas-Zinc Minerals Corp.

TODAY the petroleum industry furnishes approximately two-thirds[1] of all the energy used in the United States with the remaining one-third being obtained from coal and water power. The growth of the petroleum industry as a supplier of energy has been paralleled however by the increase in per capita energy consumption in the United States. This consumption has doubled in the last 50 years. One-half of the energy obtained from petroleum products is used for transportation, heating and electrical power in the proportions 4:2:1, respectively. The remaining energy is used for other purposes. This important contribution of the petroleum industry to our civilization through the medium of energy supply is ample reason for petroleum companies to become highly interested in any new energy source. Nuclear energy is such an energy source and its tremendous potentialities command the attention of those engaged in the supply of energy.

Importance of New Energy Resources

Since petroleum and energy have become almost synonomous, it might be justified to modify the title of this presentation to "A Petroleum Company Looks at Btu." The basic business of the petroleum industry is the sale of energy, which stated in another way, is the sale of BTU. Accordingly, the characteristic long-range planning of petroleum companies would be expected to include a serious consideration and careful evaluation of new energy resources, although the economical utilization of such resources leaves yet substantial improvements to be desired. The civilization of the 20th century and particularly the American standard of living is deeply anchored to an ample supply of energy. While opinions concerning the exhaustion of conventional energy sources vary considerably, all predictions have one point in common. That common ground is that some day these resources will be entirely exhausted. The combination of diminishing supply of the conventional fuels and increased demand for energy means that new energy processes will automatically become more competitive as time progresses. The histories of other developments have shown that the cost of production declines as utilization is increased and experience is thereby accured. We may expect that nuclear energy, whose utilization is today substantially in the planning phase, will rapidly approach practicability.

These factors should serve to stimulate the interest of major energy suppliers to the extent that a careful appraisal should be made of this newly-opened horizon. Such an appraisal should not be limited to the review of statistical developments. The furnishing of atomic energy is a highly-technical undertaking. Those who want to be active in the field at the time when a competitive level is attained must make an early start in order to accumulate technical know-how and in order to educate a qualified and well-versed staff. In the achievement of these goals, there is no substitute for creative work.

Government Controlled

One other aspect of the atomic energy industry should be considered. The industry of today is substantially government controlled. Although the governmental agencies have made significant progress in their program of turning over atomic energy to private industry, the fact remains that these agencies continue to control the economics of most phases of this new industry. In the field of raw materials, the government is the sole purchaser. It has set up price schedules which are guaranteed until 1962. For the following five years, the government has established a policy through which concentrate, the product manufactured by uranium mills, is purchased at a predetermined price. Consequently, with an assured price and a customer whose credit is good, one may enter the field with confidence and, with careful planning of oper-

About the Author

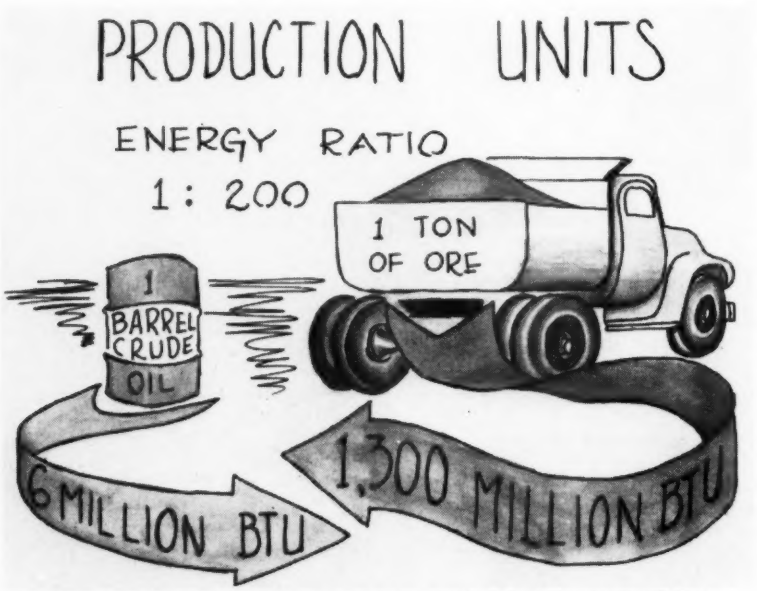
GERHARD HERZOG received his degree in mechanical engineering and his Ph.D. in physics from the Swiss Institute of Technology. He was elected associate professor of physics at the Swiss Institute in which capacity he served for approximately five years.

Herzog came to the United States in 1938 and was research associate to Dr. A. H. Compton at the University of Chicago in the field of cosmic rays. In 1940 he joined the staff of the Geophysical Laboratory of The Texas Co. in Houston and since 1947 has held the position of director of research of the Producing Department of The Texas Co. In 1956 he was made a director and a vice-president of the Texas-Zinc Minerals Corp. which handles the uranium interests of The Texas Co.

[1] All figures are approximate or orders of magnitude only.

ations, have a reasonable expectation of a modest profit. The diversion of investment funds to a longe range project has to be weighed in the light of its potential.

While all developments in the field of atomic energy will play an important part in the future of the petroleum industry, I wish to consider from the viewpoint of a petroleum company only the development of adequate reserves of fuels capable of producing atomic energy. Since, at the present stage of knowledge, the production of energy by fission presents the most feasible peaceful application of atomic energy, the discussion will be restricted to naturally-occurring uranium. Other nuclear energy processes appear on the horizon, particularly the fusion of light elements. Whereas this process has been developed for military purposes, it has not been harnessed into a controllable process, useful in peaceful applications. However, these who today venture into the industry of fission will have a shorter step to the energy creation by fusion if and when this process becomes feasible.



In the oil industry, the unit of production is the barrel while in the uranium industry the unit of production is the ton. A comparison reveals that one ton of a characteristic uranium ore stores an amount of energy equivalent to that found in 200 bbl of crude oil

Oil vs. Uranium Geology

At the outset, it is well to remember that the petroleum industry, in its search for oil reservoirs, rapidly passed through the period when such reservoirs could be detected by surface indications such as seepages. Thereupon, the industry was faced with the problem of discovering the "blind" reservoirs, those of which there were no surface indications. To meet this challenge, the industry developed knowledge concerning geological factors and exploration techniques. Since it appears that the day of discoveries of substantial uranium deposits by outcrops is nearing an end, the application of experiences in oil exploration accumulated by petroleum companies should be considered in relation to the discovery of uranium deposits.

The petroleum industry has acquired a great deal of knowledge concerning geological factors. On the one hand, these control the occurrence of petroleum and, on the other hand, they are helpful in the search for reservoirs. Petroleum companies have contributed to geological knowledge, to geological experience, and to the training and thinking of geologists. Although the origin of uranium deposits is of different nature, those engaged in uranium exploration learn more and more to apply the thinking of petroleum geologists. For example, most uranium deposits in the Shinarump formation are located in old river channels. Oil deposits sometimes have similar habitats. Oil geologists are accustomed to explore for structure rather than for oil. Similarly, uranium geologists are learning to employ this indirect method. In the Colorado Plateau particularly, the finding of an old river channel narrows the exploration to preferred and limited acreage. This should not be interpreted to mean that all uranium deposits are in channels. Uranium geology and exploration is yet in its infancy. Real progress will be made when more is understood of the occurrence and original deposition. It seems neither unreasonable nor pretentious to assume that geologists trained in the petroleum industry have an excellent starting point to become useful in uranium geology.

Specialized Exploration Methods

In being forced to resort to indirect methods in its search for oil, the petroleum industry developed specialized exploration methods such as the seismograph, the gravity meter, and the magnetometer. The uranium exploration is still lagging in the application of such tools. Although efforts are being made by the staffs of the Atomic Energy Commission and of the U. S. Geological Survey, to apply geophysical tools, very little of practical significance has resulted. This does not mean that further effort will not be successful. It would not be surprising that the entry of private industry might expedite this process. The uranium industry has borrowed from the petroleum industry the technique of measurements in bore holes. Mostly, radioactive logging tools are being applied in uranium exploration. It seems reasonable to expect that other logs depicting parameters such as electrical resistivity and acoustical velocity will find their useful place. Finally, it is not to be overlooked that drilling in itself has been highly perfected by the oil industry. Its drilling know-how is being applied to the drilling of uranium prospects. Exploration departments of the petroleum industry have the necessary background so that they may step into exploration for uranium with a minimum of additional training.

Production Units

The prime question which faces a petroleum company entering the field of uranium production involves a comparison of the energy available from petroleum products with the energy available from nuclear reactions. For the purposes of comparison, the energy potentially available in each of the fuels, crude oil and uranium, will be compared without reference to the efficiency with which these fuels may be utilized at present. The rapidly-improving technology in the field of nuclear power is regarded as justification for this basis.

One lb of crude oil contains 20,000 Btu of energy. In comparison, one lb of uranium contains 200,000,000 Btu or 200 mega or m. Btu. (This refers to uranium with its natural composition consisting of 0.7 percent of the isotope with the atomic number 235 and 99.3 percent of the isotope with the atomic number 238.) This comparison reveals that an equal weight of uranium stores 10,000 times as much energy as does crude oil.

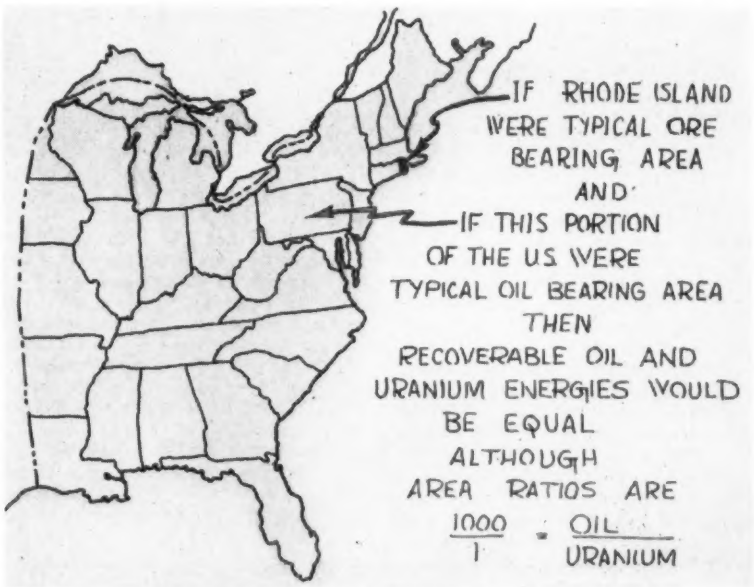
In the oil industry, the unit of production is the barrel while in the uranium industry the unit of production is the ton. For practical purposes, it is of interest to compare the energies available in these units of production. Whereas the energy content of different crude oils does not vary appreciably, the energy per ton of ore is directly dependent upon the grade of the ore. Throughout this discussion, an average grade of 0.3 percent U_3O_8 will be used. Such an ore contains six lb of U_3O_8 per ton of ore. One ton of ore contains 1200 m. Btu while one bbl of oil contains six m. Btu. Therefore, one ton of a characteristic uranium ore stores an amount of energy equivalent to that found in 200 bbl of crude oil.

The producer of crude and the miner are more accustomed to think in quantities which correspond to practical oil reservoirs and ore bodies. By comparison of the energies contained, a crude oil reservoir of 1,000,000 bbl is equivalent to an ore body of 5000 tons. As will be shown later, 1,000,000 bbl of oil constitute an average reservoir as found domestically. An ore body of 5000 tons is not considered unusual in the least. Since in the uranium industry a 5000 ton mine is considered a very small operation, the operation of such a mine might be compared to a stripper well in the oil industry.

An examination of one cu ft of rock in terms of the properties used in the oil industry and in the mining industry will demonstrate how the fuel deposits may be evaluated while in place with respect to the energies recoverable from each of the deposits. In the case of oil-bearing rocks, the term "porosity" refers to that volume of the rock which can be occupied by fluids. If a porosity of 20 percent is taken as an average value for oil-bearing rocks, then 1.5 gal of fluid can be accommodated per cu ft of rock. However, hydrocarbons do not occupy the entire fluid space. Expressed as a percentage of the total fluid space, the term "oil saturation" denotes the fraction of fluid space occupied by hydrocarbons. A reasonable value of oil saturation is 70 percent which, when applied to the one cu ft of oil-bearing rock, means that one gal of oil will be found per cu ft. Since only ⅓ of the oil within the rock may be recovered by primary producing methods, the recoverable energy in one cu ft of oil-bearing rock will be of the order of 50,000 Btu.

Whereas the oil industry customarily thinks in terms of volumes, the mining industry deals with weights. The term "tonnage factor" expresses the number of cubic feet of rock per ton. Since an average tonnage factor for uranium ores is 13, the one cu ft of uranium-bearing rock will weigh 0.08 tons. With a grade of 0.3 percent U_3O_8, the cubic foot of rock contains 0.48 lb of U_3O_8. Since only 90 percent of the ore is recoverable by economical mining practices, only 0.43 lb of U_3O_8 will be recovered. While trying to recover the highest economical percentage of ore it is usually necessary to take with it some barren ground. Dilution usually can be held to approximately 10 percent. It does not change the amount of metal contained in the original cubic foot of rock, it does however add to the mining cost per pound of uranium. The recoverable energy in one cu ft of uranium bearing rock will be of the order of 85 m. Btu.

This comparison reveals that there exists in one cu ft of uranium-bearing rock 1700 times as much recoverable energy as in one cu ft of oil-bearing rock.



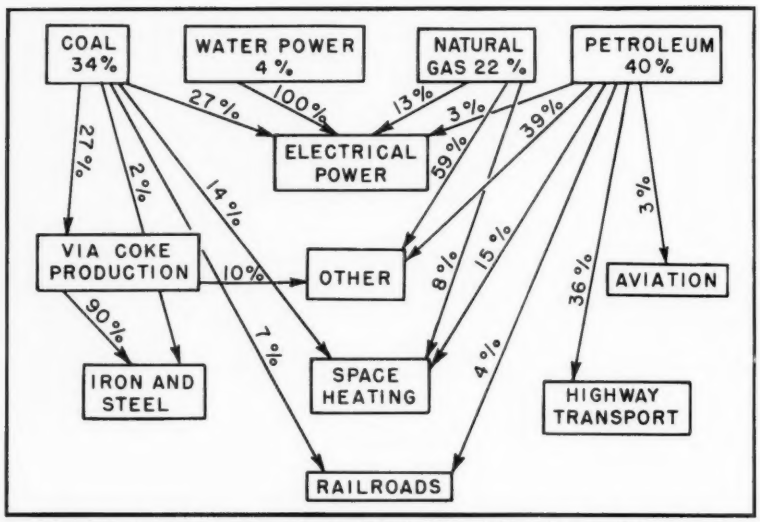
An areal comparison of oil and uranium energies

Exploration for BTU

The problem of exploration for deposits of either oil or uranium may first be considered in terms of the areal extent of an oil reservoir relative to the areal extent of a uranium deposit where the total amount of potentially available energy is the same in each fuel deposit. For this purpose, a deposit may be considered which contains 500,000,000 m. Btu. This amount of energy would be found in a uranium ore deposit containing 400,000 tons. If the ore occurred in a pay thickness of ten ft, the ore body would cover an area of 13 acres. To furnish a comparable amount of energy, it would be necessary to discover an oil reservoir containing 90,000,000 bbl. Such a reservoir would cover an area of 13,000 acres if the oil sand had a 20 ft pay thickness. This means that the oil reservoir covers an area 1000 times that of the ore body. In terms of exploration by drilling, the significance of this is that the drill holes must be spaced approximately 30 (approx. $\sqrt{1000}$) times closer together in the search for the ore deposit as compared to the search for the oil deposit.

In order to arrive at a practical figure for the frequency of occurrence of oil reservoir and uranium deposits, two areas, one favorable to the occurrence of uranium and the other favorable to the occurrence of oil, have been selected. In the Gulf Coast of Texas, an area of 100 by 100 miles (10,000 square miles) has been selected covering ten counties and centering at Houston, Tex. A count of the oil occurrences in this area reveals a total of 286 petroleum fields so that an average of one petroleum deposit is found for each 35 square miles. In considering an area 100 by 100 miles covering the White and Red Canyon in the Colorado Plateau and centered at Blanding, Utah, a total of 419 known uranium deposits are found or a deposit for each 24 square miles. This comparison reveals that frequency of occurrence for uranium and oil may be taken as being of the same order of magnitude, namely 300 deposits per 10,000 square miles.

With this frequency as a basis, the exploration effort required to find an oil or uranium deposit may be compared for a 5000 acre area of interest. In 1952, 68 percent of the oil fields discovered contained less than 1,000,000 bbl. Accordingly, the exploration program will be set up to locate one oil reservoir of 1,000,000 bbl. This will be compared with the search for a uranium deposit of 100,000 tons in the same area. An oil reservoir of 1,000,000 bbl would cover 140 acres



Utilization of energy resources in the United States, 1953. (Source: Resources of the World, California Institute of Technology, 1956.)

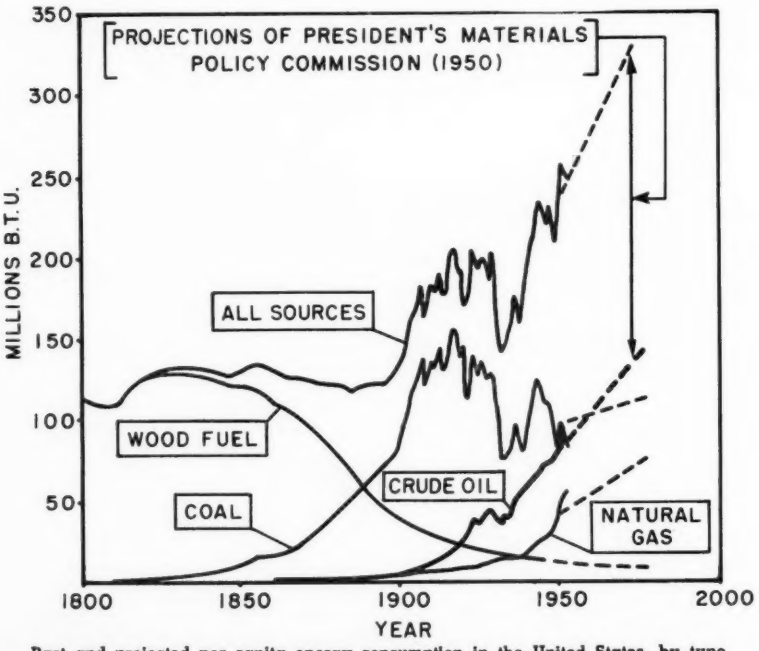
so that 35 reservoirs of this size could be placed within the 5000 acres. In order not to miss a reservoir of this size, 35 wells will have to be drilled. The average well depth in 1955 was 4000 ft. Such an exploration program however, is not economical. Practical experience leads to the drilling of only about three wells in this area. (Some reservoirs will be missed.) With a cost of $5.00 per ft, omitting the casing cost, the cost per well is $20,000 or a total cost of $60,000. A million barrels of crude contain 6,000,000 m. Btu. Under such a drilling program, $1.00 finds 100 m. Btu.

The 100,000 ton uranium occurrence covers four acres. A simple calculation reveals that 1250 holes would be required to insure finding the four acre deposit in the area in question. For practical exploration this number shall be reduced in the same proportion as was done in the oil case. There the 35 holes were reduced to three and here the 1250 are reduced to 100. Assuming a drilling depth of 500 ft and a cost of $2.00 per ft, each hole costs $1000 or a total drilling cost for the prospect of $100,000. The 100,000 ton deposit contains 130,000,000 m. Btu. An exploration dollar in the uranium case develops 1300 m. Btu.

A uranium exploration dollar finds 13 times as many Btu as an oil exploration dollar.

In comparing the exploration costs in the search for oil and uranium it has been necessary to make certain assumptions. Since the data may be considered in several different ways, it should be emphasized that the comparisons are intended to be relative only. However, it is clear that a dollar in uranium exploration has the opportunity to discover more energy than does the oil exploration dollar.

The monetary value of a Btu contained in crude oil and in uranium is not the same. Whereas crude oil takes relatively little cost to convert to the refined product, the additional cost is substantial for converting uranium ore to uranium metal or possibly to enriched uranium metal. However, this aspect of the energy problem is not within the scope of this discussion.



Past and projected per capita energy consumption in the United States, by type of fuel. (Source: Resources of the World, California Institute of Technology, 1956.)

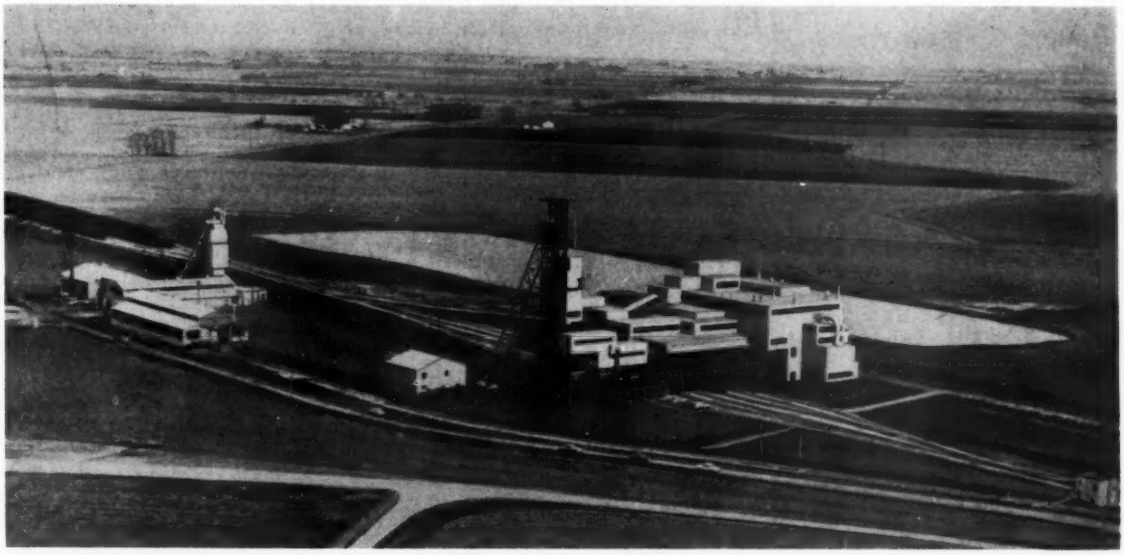
Reserve and Production

A recent figure on uranium production gives 3,000,000 tons per year or four billion m. Btu annually. The crude oil production in 1955 was 2.5 billion bbl, equivalent to 15 billion m. Btu. Energy in the annual production of crude oil is only four times that of uranium! This is an astoundingly small ratio.

The total proven reserves of uranium in the United States are estimated at 30,000,000 tons. The total domestic liquid hydrocarbon reserves at the end of 1955 were 37 billion bbl. From an energy point of view, this oil reserve is equivalent to 180,000,000 tons of uranium ore. The energy contained in our proven oil reserves is only six times that of the presently known uranium reserves.

Uranium Is to Petroleum as Youth Is to Age

While this discussion has oversimplified many of the problems involved, the energy method provides an interesting picture of the prospects facing petroleum companies in relation to the uranium industry. At present, uranium is to petroleum as youth is to age. On the one hand there exists energy almost limitless, yet relatively untamed and unharnessed, its ultimate character and application unknown. On the other hand, there exists, coupled with a more limited amount of energy, the versatility developed through growth and the ability to apply the available energy to a variety of purposes. As youth and age are complementary and derive from each other certain strengths, so it would appear that uranium as a source of atomic energy may be related to petroleum and the petroleum industry.



The use of settling ponds is a favored method of clarifying cleaning plant water with many coal preparation men

Washery Water Clarification

Survey by Committee on Coal Preparation shows how and why a cross section of the industry removes fines from cleaning plant water

FINE coal has always posed a problem to the coal preparation man. Not the least of these problems is what to do with the extreme fines that are carried in circulating wash water or water that is bled from the preparation plant. The Committee on Coal Preparation of the American Mining Congress is taking a close look at the question of washery water clarification and its first step was to find out how various coal companies are handling their individual problems. A cross section of the industry was surveyed to gather the information that is summarized in Table I and to find the answers to some basic questions.

Closed Circuits

For some time it has been the general thought that "closed-circuit" operation was the ideal answer to the problem, but there is some difference of opinion within the industry as to the exact meaning of "closed-circuit." A large segment of the coal preparation fraternity, as is brought out in Table I, feel the term means a system in which no water is bled off. However, others feel it means a system in which all of the solids are recovered. Historically, the term also implies that the job, whether it be recovering all solids or eliminating plant bleed, be done without the use of impounding areas.

Ideally, of course, a closed circuit would fill all three of the above qualifications (all solids recovered and no water bleed in a system using no impounding area) but this is not always possible. At some coal cleaning plants clear water is always required. It is not unusual to have the fresh water needed to satisfy the requirements of centrifugal pump glands exceed make-up requirements. Consequently, an excess of water is admitted to the circuit at all times.

In addition, large volumes of fresh water are frequently required for spraying clean coal, particularly where the product will find its way into a domestic stoker market. This is especially true of the midwest, although the practice is not unknown in the eastern bituminous coal fields.

At plants where make-up water exceeds the water lost by adherence to clean coal or refuse, a water clarification system in which no water is bled off is an impossibility. Primary objective for the cleaning plant operator finding himself in this situation would be to remove the solids from the water that is discharged to the watershed so as not to contaminate the stream system, or, in cases where there is a water shortage, to clarify the circulating water and impound the excess to be used at the times that water is in short supply.

Need Impounding Areas

A review of the data shown in Table 1 reveals that in every instance where the cleaning plant operator is complying with Pure Stream Legislation, sludge ponds are used, either for emergencies or for use in the impoundment of solids that are being continuously bled from the circulating water system.

It is the consensus of the committee that considerable glory has been taken away from the term "closed-circuit" as historically applied in coal preparation. A circuuit that is closed mechanically (without the use of impounding areas) is often impractical and often undesirable. The latter is particularly true when high ash slimes interfer with the quality of the product—from either a moisture or ash standpoint. In instances of this nature, impounding areas are required and to attempt closed-circuit operations would not be desirable.

In the light of the above, the Committee on Coal Preparation of the AMC Coal Division has agreed to

TABLE I

	MINE NO. 1	MINE NO. 2	MINE NO. 3	MINE NO. 4	MINE NO. 5	MINE NO. 6	MINE NO. 7	MINE NO. 8	MINE NO. 9	MINE NO. 10	MINE NO. 11	MINE NO. 12	MINE NO. 13	MINE NO. 14
Use Settling Ponds			X	X	X	X			X	X		X	X	X
Use Sludge Tanks	X	X	X				X	X	X					X
Use Static Thickners*				X	X	X		X		X			X	X
Use Cyclone Thickners				X	X				X					X
Use Filters	X (Vacuum)	X (Cent.)		X (Vacuum)	X (Vacuum)	X (Vacuum)		X (Vacuum)	X (Vacuum)			X (Screen)		X (Vacuum)
Clarifying to comply with P. S. L.†			X	X	X	X			X	X			X	X
Amount minus 48 Mesh in R. O. M.	2%	—	4-5%	4.5%	1.5%	3%	9%	3%	8.1%	2.1%	18.2%	15%	7%	4%
Size Wasted	200Mx0	100Mx0	100Mx0	—	100Mx0	—	20Mx0	300Mx0	200Mx0	28Mx0	3/64"x0	1mmx0	—	325Mx0
Definition of Closed Circuit														
All solids recovered								X	X	X				X
No water bled off			X	X	X	X	X	X			X	X	X	

* Static thickners include: Settling cones, boots, desliming devices, etc.
† P.S.L.—Pure Stream Legislation.

consider a sludge pond or impounding area as a physical part of the cleaning plant circuit. In this way, a plant will be considered as operating in closed-circuit when any water bled from the system meets Pure Stream Legislation even though sludge areas are used to remove solids from the water.

How the Job Is Being Done

Several case histories are set forth below showing how individual companies are handling their washery water clarification problem. This information is summarized in part in Table I.

MINE NO. 1: All fine coal is directed to two large settling tanks where it is recovered, dewatered, centrifuged, and heat dried. Water and fine solids from each tank are overflowed at a rate of about 1400 gpm to a sump from which the slurry is pumped to a battery of five 14-in. cyclones. Overflow from the 14-in. cyclones is fed to 12 8-in. cyclones with the underflow from both batteries of cyclones being sent to a nine-disc vacuum filter for solids recovery. The eight-in. cyclone overflow is put back into the circulating water system, but to prevent a build-up of more than 10-percent solids it is necessary to bleed about 300 gpm containing 98 percent of the 200 M by O solids.

MINE NO. 2: The ⅛-in. by O coal is flumed into a sludge tank where settled solids and water are pumped to a solid bowl-type centrifugal filter. A portion of the effluent is wasted with the remainder being returned to the circulating water system.

MINE NO. 3: At this eastern Ohio preparation plant, effluent containing minus 100-M material flows by gravity to a seven-acre pond where the solids settle out and are later pumped by a dredge to a storage area for subsequent beneficiation by froth flotation. Clear water is returned to the plant which would be faced with a water shortage if water from the settling pond was not available for reuse. Between four and five percent of the raw coal feed is minus 48 M.

MINE NO. 4: The water clarification system at this property in Pennsylvania consists of one 75-ft thickener, five 14-in. cyclone thickeners, 110 3-in. cyclone thickeners, one 12-disc 8-ft 10-in. vacuum filter, two 4-disc 8-ft 6-in. vacuum filters, and two settling ponds. The plant is a hydro and hydrotator type and it is important to keep the solids content of the circulating water constant, preferably around 15 percent, as these solids are used as a media. When there is a solids build-up of over 15 percent, circulating water is pumped to one of the settling ponds at the rate of 300 gpm for 15 to 20 minutes. This is done on the average of twice a shift. As a rule this water has a solids content of from 17 to 20 percent. About 200 tons of this material is being recovered each month. It has an ash content of 18 percent and a sulphur content of three percent and is shipped with steam coal from the preparation plant.

There is no scarcity of water and no water is being discharged to the river. Four and a half percent of the raw feed is minus 48 M. None of the coal is being wasted as all solids are recovered from the settling ponds.

MINE NO. 5: At this central preparation plant in West Virginia, cyclones and vacuum filters are used in the preparation plant to retain solids, and approximately 30 acres of settling ponds are used to clarify water from the refuse circuit. Three reasons are listed for clarifying plant water; to retain as much usable water in the plant as is possible; to retain part of the solids—that which is low in ash content; and to conform with Pure Stream Legislation. There is no scarcity of water. Another reason for clarifying plant water, although not a prime reason, is to prevent a build-up of solids in the system.

One and a half percent of the raw coal feed is minus 48 M. All minus 100 M coal is being wasted and minus 48 M is wasted from some of the units.

MINE NO. 6: A 125-ft thickener is used to clarify recirculating water and a settling pond to clarify waste water at this plant which is located in Pennsylvania. There is a scarcity of water for the plant but water is also clarified to prevent a build-up of solids in the system. In addition, coal fines are recovered and Pure Stream Legislation complied with. Three percent of the raw coal feed is minus 48 M.

MINE NO. 7: A need to conserve water and to avoid stream pollution are primary reasons for water clarification at this cleaning plant in central West Virginia. In addition, there is a need to clarify plant water to prevent a build-up of solids in the system. The company reports that a settling tank is used as its method of clarification. Nine percent of the raw coal feed is minus 48 M and the 20-M by O coal is being wasted.

MINE NO. 8: At this West Virginia coal preparation plant, a drag tank is used to settle out the ¼-in. by O coal. Sixty-M by O fines are settled in a 50-ft thickener for recovery in a disc-type vacuum filter. A desire to conserve water, which is in short supply at times, the existence of a market for the 60-M by O fines, and a wish to prevent stream pollution are the reasons given for clarifying

cleaning plant water. About three percent of the raw coal feed is minus 48 M. Coal being wasted is 300 M by O, about 20 percent minus 48-M material in the raw coal feed. It contains approximately 45-percent ash.

MINE NO. 9: Settling tanks, 14-in. and 3-in. cyclones are used at this plant in Pennsylvania where the primary reason for clarifying is to recover coal. In addition, by clarifying and then bleeding of 98 percent of the minus 200 M material, which is impounded, the amount of solids in the system is kept constant. Mine water is used to augment surface water to supply the plant during dry months.

MINE NO. 10: At this plant in Illinois, fine coal is prepared in a Rheolaveur plant. Desliming cones and centrifugal dryers are used to separate the plus ½-mm coal from the circulating water system. The ½ mm by O, which contains 85 percent fireclay and 15 percent recoverable coal, is wasted to an abandoned open pit. Only clear water overflows the property, a requirement of Pure Stream Legislation. Two and one-tenth percent of the raw coal feed is minus 48 M. The company does not attempt to recover the minus ½-mm coal because it offers a difficult sales problem and a relatively low value in comparison with the high cost of recovery.

MINE NO. 11: At this West Virginia plant, 18.2 percent of the raw coal feed is minus 60 M. The $\frac{3}{64}$-in. by O coal is being wasted.

MINE NO. 12: Settling ponds and vibrating screens are used in the water clarification system at this mine in Virginia to prevent a build-up of clay in the circulating water and to comply with Pure Stream Legislation. Approximately 15 percent of the raw coal feed is minus 48 M. The minus one-mm coal is wasted to the settling ponds.

MINE NO. 13: Pure Stream Legislation requires this company, which operates a preparation plant in West Virginia, to clarify washery water. There is also the need to prevent a build-up of solids in the system. A sludge pond is used to impound bleed from the plant. Seven percent of the raw coal feed is minus 48 M.

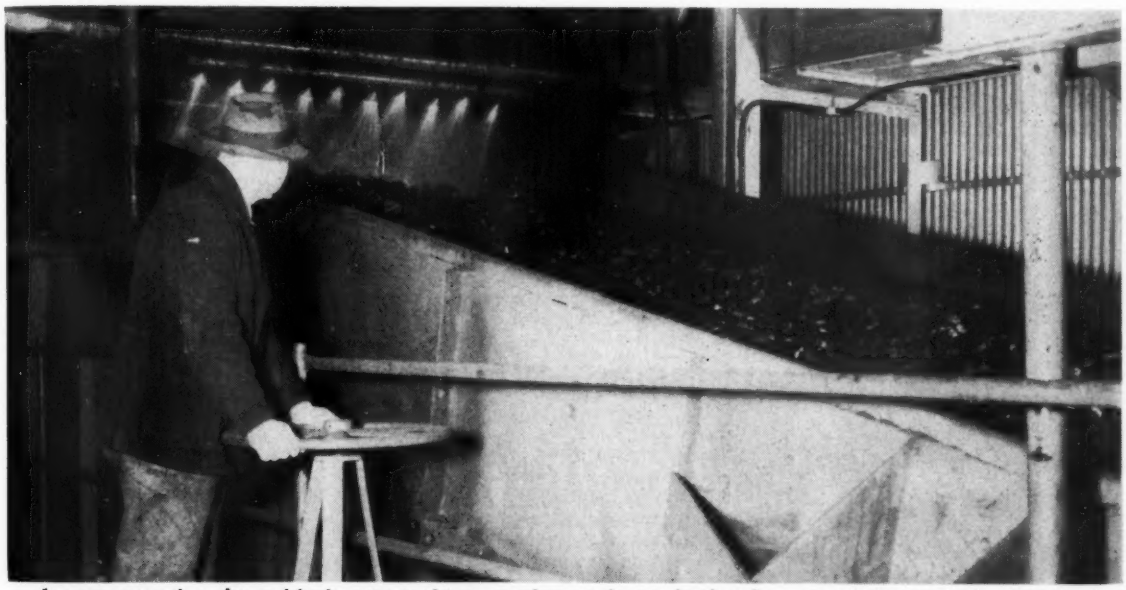
MINE NO. 14: Clarified water from the constant head cone in this large preparation plant in Pennsylvania is used on the sprays to rinse the coal at the primary heavy medium vessels and the secondary heavy medium vessels. This water then passes to the new coal drag tank and the overflow is pumped to the resettling water constant head tank. Clarified water from the constant head cone is also used as vertical water for the refuse boxes at the fine coal launders. This water then passes to the reject drag tank and the overflow is either pumped to the 150-ft thickener feed sluiceway or to the clarified water head cone.

Recirculating water used as push water at the fine coal launders passes to the fine coal boots. Overflow from the boots is pumped to 14-in. cyclones and overflow from the cyclones goes to the 150-ft thickener sluiceway. Underflow from the cyclones goes to the vacuum filter vat. The 150-ft thickener underflows are pumped to the vacuum filters, and the overflow is used as clarified water to the clarified constant head tank. A portion of the 150-ft thickener overflow is pumped to the 85-ft thickener, where a flocculent is added to the feed.

The company is not faced with a scarcity of water, but does have to comply with Pure Stream Legislation. Cleaning plant water is being clarified to get the highest possible quantative return and at the same time produce an acceptable product.

An attempt is made to hold solids in the recirculating water to a maximum of five percent. Ninety percent of the minus 325- M material is being wasted. This is approximately 1½ percent of the raw coal feed. Four percent of the raw coal feed is minus 48 M.

Preparation plant management reports that complete recovery of solids in the washery water at present would require the addition of flotation cells, heat drying and filters. In answer to the question, "What percentage of the solids in the washery water do you feel can be recovered economically?", the following was reported: "We know it is more economical to waste a certain percentage of these high ash slimes by pumping than to strive for complete recovery. The portion of high ash slimes remaining does not affect our final results to the point that they are objectionable."



In many cases the volume of fresh water used to spray clean coal exceeds plant loss, necessitating a steady plant bleed

Operators Corner

Why Have a Preventive Maintenance Program?

To get sustained high production and to reduce maintenance and repair costs to a minimum over the long run

THE objectives are just that simple and these things are important to all operators regardless of the size of the operation. Many operators haven't taken advantage of a PM program because they think special crews and an expensive record system are requirements. Actually, by thinking this way, many mine operators are denying themselves the use of a management control tool of the highest order. A good PM system reduces record keeping to the absolute minimum and can be operated without hiring special personnel.

Most equipment makers and engine builders are happy to supply their users with PM schedules which are based on actual experience gained in field operation. These schedules break down the necessary operations to their simplest forms, and eliminate the need for specialists as much as possible. Many of the operations can be performed by the equipment operator with a short period of training.

Three Requirements

The important requirements of a successful PM program are — first, that there be a definite schedule of operations; secondly, that those operations must be assigned as a responsibility; and third, that supervision must see that these responsibilities are carried out.

The schedules are generally broken down according to the number of hours of operation in a maintenance period—for example, daily, 100 hours, 500 hours, and 1000 hours. An examination of the forms supplied by one of the engine builders illustrates this point. All of the daily checks can be performed by an operator in a few minutes at the start of the shift and a few minutes at the end. The 100-hour inspection can also be performed by the operator and an absolute minimum of equipment is required. Just teach him how to do the job properly and see that he does it.

For the 500-hour inspection, the first thing to do is to duplicate the 100-hour inspection, and then go into a little more detail. The operator can perform the 500-hour inspection with the exception of the tune-up that is called for which should be handled by someone trained to do the job.

The 1000-hour inspection, however, once the 500-hour inspection operations have been performed, needs to be taken over by a qualified mechanic.

Everything Important

It is important to remember that there is no item so unimportant that it can be overlooked. Fuel and lube oil consumption are always among the important observations. These are indicators of engine condition, along with the general performance level. Any change in fuel or oil consumption which can't be explained by a change in operation should be investigated thoroughly. This is also true of any deviation from normal pressure and temperature readings.

A control schedule should be arranged so all the equipment doesn't come in for a 1000-hour inspection at once. Staggering these jobs will reduce manpower requirements.

One more item in the records is an equipment history. Record major items of repairs and changes from standard sizes such as bearings, rings, etc. This whole record, fuel and lube consumption, cost of maintenance, cost of repairs, hours between overhauls, and cost of overhauls, can be an extremely important guide when a new equipment purchase is contemplated.

Start This Way

Start your PM program by getting a set of forms from the manufacturer of your equipment. These schedules are based on experience and usually are conservative. At the start, follow the schedule exactly. After you have gained some experience you will undoubtedly find that your operation isn't quite average. Your actual operation will determine your PM requirements. You may find it desirable to adjust the published schedule to suit your own conditions. You may

Keep equipment working by keeping it in good repair

find that you can stretch the period on individual operations. Perhaps the 500-hour period can be 600 hours, and the 1000-hour inspection can become 1200 hours. Tailor the program to your operation when you have proved —not when you think—your operation calls for deviation from the standard procedure for greatest economy.

Every equipment user needs a PM system to obtain the life and production expected from equipment. It's a management control to see that all necessary service is performed on time, and that only necessary service work is done. If you do not have a PM program now, you will find after you start with yours that the performance of your equipment will improve, you'll get more production, equipment life will be longer, and you'll make more money.

Your equipment dealer or manufacturer will be glad to help you get started with a ready-made system.

A preventive maintenance program requires a definite schedule of equipment service assigned as a responsibility. This is not a difficult thing to do at any mine—large or small

Industrial Engineering and Coal Mining

(Continued from page 53)

advance. This is the way to good cooperation.

Training programs: Every company should have some kind of a training program and when it does not it is constantly falling into pitfalls. A bulletin board can contain suggestions. A big sign board can impress the employes. Individual sheets of paper containing instructions on certain items can be sent to the employe when needed and a record kept of them. Everything grows more complicated and changes faster and the company needs to have each employe informed in the right way about everything.

Team development: One of the most beautiful sights is when in a company both the work process and the organization have been engineered with considerable precision so that everything and everybody works together with a high pitch of cooperation. It is a source of joy and profit.

Industrial engineering for sales: Motion and time study and work simplification are being applied to sales far and wide among some companies with remarkable results. In a sense, time is life and time is money and time cannot be neglected any place. It is applied to sales in just the same way as to production.

Definition of Industrial Engineering

(1) To some extent all of these procedures have been going on all of the time for many years in some place or other, and everyone does at least part of them. The main difference may be that in industrial engineering the company sets up a procedure whereby in some way or other all of these things which it has found good will be done all of the time instead of part of the time and applied every place where a good use for them may be found. This makes a comprehensive program out of what had been haphazard.

(2) Industrial engineering may be considered a problem solving procedure. The industrial engineering procedures are those which many analysts working all over the country have found to be the most successful in solving the more difficult problems which many businesses have. It is an orderly way of solving one problem after another regardless of the kind of problem at as fast a rate as possible.

(3) Measurement—More and more ways are found to measure things that have not been measured before and to measure things already measured but more accurately. This measurement helps to determine the most important problems, provides more accurate information of all kinds, locates the bottlenecks, finds the slowest or weakest places in the production activities, tells the story more convincingly and provides more active motives.

(4) More life—All of us want to have more life. Each one of us has something further he wants to do and desires expansion of his present activities, a next goal either in business or personal. We want to go places and do things and these procedures have been provided to secure the ways and means.

(5) Enjoy your work. The old way was resignation to being miserable a great deal of the time while working, at least for the ordinary workman. The new idea is that with so much time spent at work this time ought to be enjoyed at least to a considerable degree. People accomplish more when there is joy in their hearts. We learn to demand results of ourselves and in the right way to do whatever is necessary to get the results. Genius may be a tremendous capacity for taking pains. After the necessary rules are mastered such as industrial engineering procedures, a good manager becomes free to accomplish real goals with his business.

(6) Perfection—A vast orderliness is necessary in all the activities and materials. This makes a program that moves slowly but surely because it is based on the best facts. All the good ideas are written down and saved, presented on charts which make them more vivid, and used in planning the necessary changes. Many of the ideas are followed up just like some of the accounting records as books are made to balance and results are shown to have been accomplished. It is a way of both persuading and insisting that people make changes when they seem to be needed in order to adjust the business to the changing conditions which happen in this life. Changing is one of the most difficult things we do, and all of this field of industrial engineering is necessary in order to get the changes made after finding out what changes ought to be made.

If this series of definitions seems confusing to you, rest assured that many bright minds have found it difficult to state a true definition of this subject.

Wheels of GOVERNMENT

AMC

As Viewed by HARRY L. MOFFETT of the American Mining Congress

THE Eisenhower-Nixon team won a resounding victory at the polls last month and the Nation can thus expect a continuation of the policies of the present Administration.

While the Republican party retained the White House, it did not fare so well in Congress. The Democrats retained control of both the Senate and House, although the Senate majority (49 to 47) is so slim and that loss of one member could result in its being organized by the Republicans. It is expected, however, that there will be a renewal of the coalition of Republicans and conservative Democrats which has been so effective in the past.

If the Senate remains in Democratic control, most of the chairmen of the committees dealing with matters of interest to mining in both Houses will be the same as in the past Congress. On the Senate side, the Finance Committee will be headed by Senator Harry F. Byrd (Dem., Va.); the Interior and Insular Affairs Committee by Senator James E. Murray (Dem., Mont.); the Judiciary Committee by Senator James O. Eastland (Dem., Miss.); the Appropriations Committee by Senator Carl Hayden (Dem., Ariz.); the Interstate and Foreign Commerce Committee by Senator Warren G. Magnuson (Dem., Wash.); and the Labor and Public Welfare Committee by Senator Lister Hill (Dem., Ala.). Over in the House, the Committee chairmen will be as follows: Rep. Jere Cooper (Dem., Tenn.), Ways and Means Committee; Rep. Clair Engle (Dem., Calif.), Interior and Insular Affairs Committee; Rep. Graham Barden (Dem., N. C.), Education and Labor Committee; Rep. Emanuel Celler (Dem., N. Y.), Judiciary Committee; Rep. Clarence Cannon (Dem., Mo.), Appropriations Committee; and Rep. Orren Harris (Dem., Ark.), Interstate and Foreign Commerce Committee.

The new Congress will convene January 7 but little concrete legislative activity is expected before early February—the reason being that the organizing of any new Congress has many facets and takes considerable time. Vacancies on Committees due to death, resignation, and defeat at the polls have to be filled before the Committees can get down to considering legislative measures.

The President plans to meet with Congressional leaders this month to discuss his plans for legislation involving domestic, foreign and national security policies. Meanwhile, he is pushing ahead with the drafting of his messages on the State of the Union, the Nation's economy, and the Federal budget.

Mineral Policy Being Drafted

With the election over, Interior Department officials have settled down to the drafting of a national minerals policy. It will be recalled that Interior Secretary Seaton has made it plain on several occasions that he will have definite recommendations in the hands of the incoming Congress at an early date.

While officials have cloaked the policy proposals now under consideration in secrecy, there have been some hints as to the general outline of the Interior Department's plans. From expressions of top officials at various industry meetings across the country, it is believed that the policy proposals will call for increased research into new uses for minerals as well as improvement in extractive processes, a stepped-up geologic and topographic mapping program, revision of the tax laws with a view towards further spurring the search for and development of our mineral wealth, and a suggested program to protect domestic producers from serious injury by foreign imports. Whether or not the policy proposals will call for some form of subsidy plan has not been indicated. There have also, of course, been indications that the Department is taking a close look at the current stockpile goals, to see whether recommendations should be made for higher objectives and thus increased buying of domestic minerals in the strategic category.

First concrete evidence of the shape the policy proposals may take may be revealed in the President's State of the Union message early in January. It is probable that the Administration's detailed suggestions, however, will be submitted later and will then be searchingly scrutinized by the appropriate Committees of Congress.

Tax Hearings Under Way

A House Ways and Means Subcommittee on Internal Revenue Taxation is holding hearings on some 28 "substantive unintended benefits and hardships" contained in the Internal Revenue Code. One of the items under study is that of oil and mineral production payments.

AMC Tax Committee Chairman Henry B. Fernald appeared before the Committee in mid-November on this subject. He suggested that the study of production payments seems to be directed to certain practices, particularly with respect to oil, which are considered to give unintended benefits either in capital gain treatment or in charitable deductions. He

Washington Highlights

MINERALS POLICY: Being drafted
TAX HEARINGS: Under way
TARIFF STUDY: Committee meeting report
OIL IMPORTS: Decision delayed
PUBLIC LANDS: New regulations out
FREIGHT RATES: Boosts sought
MERGERS: Legislation in offing
COAL SAFETY: Rulings to be published
MINERALS PURCHASES: Money running out
METAL MINE SAFETY: Hearings being held

urged the Committee, in formulating any legislation on this subject which might apply to mining, to see that it does not prevent or discourage the normal and appropriate practices and procedures reasonably applied in the mining industry. He also urged the Committee, when it considers the definition of "property" for computing the allowance for depletion, to permit taxpayers more than one aggregation within an operating unit, and that the election to aggregate should not be required with respect to any deposit until its nature and character is reasonably determined.

Meanwhile, the Treasury Department has issued proposed regulations dealing with the natural reasurces provisions of the Internal Revenue Code. The Tax Committee of the Mining Congress is giving the proposals detailed study and will file a statement with the Internal Revenue Service setting forth its suggestions for their improvement as they affect the mining industry.

Tariff Report Readied

A Subcommittee of the House Ways and Means Committee, headed by Rep. Hale Boggs (Dem., La.), which conducted a study of tariff and trade policy during the past few months, is now readying its report for the incoming Congress. Indications are that the Committee will not make any specific legislative recommendations, but will detail the studies made and point up the trade problems that require further scrutiny by Congress for possible statute changes.

A broad hint has been given that the Boggs subcommittee will continue to exist in the 85th Congress, to handle tariff proposals as they arise. The full Ways and Means Committee is expected to be wrapped up in tax matters and not able to devote its attention to tariff problems.

Oil Import Decision Delayed

The Middle East situation, accompanied by the shutting down of the Suez Canal, has brought a delay in any decision by the Administration on petitions to curtail the importation of crude and residual oil from abroad.

The Office of Defense Mobilization had held a hearing in late October on a request by independent oil producers that the President, under the Trade Agreements Act, impose a mandatory limitation on oil imports. Oil industry witnesses had urged ODM to take prompt action on the petition. Representatives of the coal industry presented a clear review of the effect of residual oil imports on the domestic coal industry, and recommended adoption of a plan under which an automatic limit would be placed on residual oil imports at any time that the coal-equivalent price of residual at New York harbor is less than the wholesale delivered price of coal at that point.

Prior to this hearing the Presidential Advisory Committee on Energy Supplies and Resources Policy had reaffirmed its earlier recommendations that importers of crude oil should voluntarily limit incoming shipments to the same ratio that imports had to domestic production in 1954.

Interior Issues Land Regulations

Regulations for carrying out provisions of Public Law 167 of the 84th Congress have been placed in effect by the Interior Department. This law provides for multiple use of the surface of mining claims and establishes a procedure for clearing up title uncertainties surrounding abandoned, dormant, unidentifiable and invalid mining claims. The regulations amplify the law and make it clear that mining claimants are entitled to use of that part of the surface necessary to their mining, processing and allied operations. They also confirm that, upon patenting, the mining claimant receives full title to his claim. In announcing the regulations, Secretary Seaton said that recommendations of the American Mining Congress for their clarification had been adopted.

Seaton has also issued proposed regulations governing the administration of Public Law 359 of the last Congress, which provided for the location of mining claims on some seven million acres of public lands withdrawn or reserved for power sites. These sites were previously closed to mining locations.

Higher Freight Rates Sought

Eastern, Western and Southeastern railroads have petitioned the Interstate Commerce Commission for an immediate 7 percent increase in rail freight rates, with hold downs on coal and lignite at 10 cents per ton. This increase is in addition to the 15 percent request sought earlier by East-West roads. The Commission refused to consolidate the Southeastern request with that of the other carriers. The East-West 15 percent plea includes a maximum 5-cents-per-ton increase on coal.

The timetable for hearings by the Commission on the original 15 percent hike was revamped so that hearings were first held on November 26 in Kansas City, with final argument there on December 3. In the Southeastern case, hearings were to be held in Washington on December 12, with final arguments December 19.

Opponents of the rate boosts have until December 24 to file statements against the proposed 15 percent rise.

Strong opposition is being voiced against any of the proposed hikes which cannot be justified as being needed to offset recent increases in wage and materials costs.

Merger Legislation in Offing

A renewed drive for early Congressional action on "pre-merger" legislation is already under way. Sources on Capitol Hill indicate that Rep. Celler (Dem. N.Y.), chairman of the Antitrust Subcommittee of the House Judiciary Committee, is determined to have a bill ready for action by the House by early March. They anticipate that the bill will cover both bank mergers and corporate mergers and acquisitions.

Support for pre-merger legislation will also come from the Administration. The Justice Department is known to have taken a stand that such legislation should be sought early next year. A Justice Department official has stated that any bill on this subject should require large companies to give the Department advance notice when they plan to merge or acquire control of other companies.

Coal Mine Safety Rulings

Bureau of Mines rulings and interpretations dealing with operation of the Coal Mine Safety Act will be published in the Federal Register in the future, according to Bureau Director Marling J. Ankeny. Heretofore the ruling and interpretations were merely issued by the Bureau without such publication.

Failure of the Bureau to publish its rulings has been raised as an issue in numerous cases appealed to the Federal Coal Mine Safety Board of Review in the past. Industry spokesmen had contended that the Bureau of Mines was subject to the Administrative Procedure Act in its enforcement of the coal mine safety law, including the requirement of publication of its interpretations.

Minerals Purchase Programs

In late November, producers of tungsten found that the Government was not in a position to purchase their output under terms of the recently-enacted minerals purchase program, for the simple reason that the Government was out of funds for administering the program.

In the dying days of the 84th Congress some $21 million was appropriated to procure domestic tungsten, asbestos, fluorspar and columbium-tantalum. This fund was expected to tide the program over until 1957, at which time Congress would take a new look at the amount of funds required for the full two years of the purchase programs. However, tungsten offerings were so large that the available funds were exhausted earlier than expected. Government at-

(Continued on page 81)

JOHN D. LOCKTON

Portrait by Fabian Bachrach

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MINING CONGRESS JOURNAL

AMC Personals

Otto Herres, Salt Lake City, has retired as vice-president of Combined Metals Reduction Co. to devote more time to affairs of the mining industry. Herres is chairman of the Lead & Zinc Committee and a veteran leader in the struggle of the western mining industry for trade and tariff relief. He was also a member of the National Minerals Advisory Council of the Interior Department.

John Teague has been elected vice-president of Nashville Coal, Inc., according to Mark E. Eastin, Jr., company president. He was sales manager prior to his promotion.

Thomas J. Hubbard was recently appointed superintendent of the Magna plant of the Utah Division, Kennecott Copper Corp. Former general master mechanic of the Magna department of mills, Hubbard succeeded **John Allen,** who retired after 43 years with the Utah Copper Division.

Promotions or transfer of seven West Virginia operating officials in the coal division of Eastern Gas & Fuel Associates have been announced.

H. A. Quenon, division manager of the low volatile division at Beckley, W. Va., has been promoted to assistant production manager with headquarters in Pittsburgh.

E. H. Shaw, superintendent of the Federal No. 1 mine at Grant Town, W. Va., replaces Quenon at Beckley. Shaw has been replaced at Grant Town by **William Laird,** previously superintendent of the Kopperston mines in Wyoming County.

Usher A. Cobb, superintendent of the Wharton No. 2 mine at Barrett, W. Va., was transferred to Kopperston as superintendent. **D. B. Shupe,** superintendent of Wharton No. 1, replaces Cobb as superintendent of Wharton No. 2. **Robert H. Freeman,** production engineer for the low volatile division replaced Shupe. **K. S. Hobbs,** production engineer for the Federal mine at Grant Town, was made production engineer for the low volatile division.

Courtney Burton has moved up from vice-president to vice-chairman of the board of Oglebay, Norton & Co. **E. W. Sloan, Jr.,** was promoted from vice-president to executive vice-president.

The announcement of three promotions was recently made by Johnstown Coal & Coke Co. **Robert Randall Bragg, Sr.,** was named superintendent of the company's mine near Cowen, W. Va. **W. C. Miller** was moved up to direct the newly established industrial engineering department of the company. He was succeeded as safety director by **Anton Brence.**

George B. Moran has joined Freeport Sulphur Co. as vice-president. In his new association with Freeport, Moran will act as vice-president in charge of domestic and foreign sales.

Three recent appointments have been announced by the Oliver Iron Mining Division of U. S. Steel Corp.

Daniel V. Dodge has been named manager of personnel in the industrial relations department. He will handle all matters pertaining to the selection and training of personnel in the administration of Oliver's personnel program.

Stuart V. Bradley and **A. Herbert Axelson** have been named assistant manager — mining engineering for Oliver. Bradley has been supervisor of ore estimates since 1951 for the Steel Corp. Axelson was assistant chief mining engineer, eastern district, at the time of his new appointment.

George Basil Blonsky has been appointed project engineer by F. H. McGraw & Co. for a $25,000,000 fertilizer plant the company is building in Korea. Blonsky previously had his own business, a tungsten mining operation out of Kingman, Ariz. Before that he spent 15 years with the Dorr Co. and Cyprus Mines Corp. Specializing in design and construction work, he served as project engineer on the Three Kids Mine, a manganese-ore beneficiation plant, Henderson, Nev.

Dr. John Robert Van Pelt has assumed his duties as president of Michigan College of Mining and Technology. He succeeds **Dr. Grover C. Dillman** who retired.

Dr. Van Pelt came to Michigan Tech from the Montana School of Mines where he had been president since 1951. While there he was also director of the Montana Bureau of Mines and Geology, which is equivalent to a state geological survey. From 1953 to 1954 he was chairman of the Secretary of Interior's committee on organization and management of the U. S. Geological Survey. Since 1952 he had been the representative of the Governor of Montana on the Western Governors' Mining Advisory Council.

Walker Kennedy was recently named president of the Liberty Fuel Co. with mines at Latuda, Carbon County, Utah. He succeeds **L. Ross Weber,** chairman and president of the firm. Weber continues as chairman of the board of Liberty Fuel.

C. A. Reed, director of the Engineering Department of the National Coal Association, has received the Percy Nicholls Award for his "outstanding achievement in the field of solid fuels." The annual award, bestowed by the Coal Division of the American Institute of Mining & Metallurgical Engineers and the Fuels Division of the American Society of Mechanical Engineers, was presented on behalf of the two engineering societies by J. B. Morrow during the dinner session of the 19th annual Solid Fuels Conference sponsored by the two groups in Washington, D. C., October 26.

Ira O. N. Swanson, eastern district general superintendent for the Oliver Mining Division of U. S. Steel Corp. has retired after 48 years with the company. Swanson began his long service with Oliver at the age of 17. He advanced progressively and in 1952 was promoted to general superintendent, the position he held at his retirement.

On October 31, **Harold P. Greenwald**, regional director for the Bureau of Mines with headquarters in Pittsburgh, retired. As regional director, Greenwald has headed up the Bureau's organization for all states east of the Mississippi River, Minnesota, and Iowa. Under his direction, the Bureau also conducted research on minerals. Greenwald became regional director in 1949 when the Bureau was first organized into regions. Before that time he had served for 13 years as superintendent of the Experiment Station in Pittsburgh and for a number of years as supervising engineer of the experimental coal mine at Bruceton, Pa.

The Board of Directors of Bunker Hill Co. have elected two men to newly-created posts of vice-president. **Wallace G. Woolf** will be vice-president in charge of Kellogg, Idaho operations and **Roger H. Cutting** will be vice president in charge of the Sales and Fabrication Division, which has its headquarters in San Francisco. Woolf has served since last year as general manager of Bunker Hill's mining, concentrating and reduction operations at Kellogg. Cutting was president of Northwest Lead Co., when it was acquired by The Bunker Hill Co., last August.

W. G. Woolf

H. H. Morfield, formerly superintendent at the Boissevain mine of Pocahontas Fuel Co., has been appointed superintendent of the Deerfield mine of American Coal Co. near Covel, W. Va. American Coal Co. is a subsidiary of Pocahontas Fuel.

William C. Schmidt and **Neal A. O'Donnell** have opened offices as mining consultants under the firm name of O'Donnell and Schmidt at 65 Broadway, New York 6, New York.

Two superintendents have been appointed in the Gary District of U. S. Steel's Coal Division. **John J. Greer**, has been appointed superintendent of countour mining operations at Mine No. 14. **Hagy R. Houck** has been appointed superintendent of No. 6 Mine. Both are near Gary, W. Va.

At the same time it was announced that **John Macom, Jr.** has been advanced to district mechanical engineer and **Roy L. Franklin** was made supervisor of training at the Lynch District of U. S. Steel's Coal Division.

— *Obituaries* —

Philip M. Snyder, 86, an early leader in the coal industry of southern West Virginia, died September 6.

Mr. Snyder's first mining property was the Mabscott mine which he acquired in 1906. Six years later he organized the Long Branch Coal Co. and in 1916 formed a number of other operating companies, including the Princewick Coal Co., East Gulf Coal Co., Fayette Smokeless Coal Co., and the Pemberton Fuel Co. When those and several other mining properties were acquired by the Massachusetts Gas Co., Boston, in 1926, he became vice-president of that company and president of its operating unit, the CCB Smokeless Coal Co. In 1933 the CCB Coal Co. merged with the Koppers Coal Co., and Mr. Snyder became its vice-president and director. He retired from active participation in the coal business in 1940 and served later as chairman of the Bituminous Coal Commission for District 7.

John Clark Pickering, 73, a widely known retired mining engineer, died October 10. He served as a consulting engineer with various organizations all over the world, including Mexico, Africa, Russia, England and South America.

Ralph R. Adams, vice-president of the Sterling Coal Co., died October 23.

Edward Wm. Koeppen, 57, assistant chief engineer for the Marion Power Shovel Co., Marion, Ohio, died near Harrisburg, Ill., October 18, while helping to adjust a power shovel which was being erected at the Saxton Coal Co. Mr. Koeppen went to work for the old Marion Steam Shovel Co., predecessor of the Marion Power Shovel Co., in 1926.

William J. Palmer, 66, vice-president in charge of manufacturing, Phelps Dodge Copper Products Corp., died August 30.

Widely known throughout the metals industry, Mr. Palmer joined Phelps Dodge in 1937 and was shortly thereafter named works manager of dent in 1952. Formerly, he was production manager for the Rome, N. Y., division of Revere Copper and Brass, and had been affiliated with Chase Brass & Copper Co., Waterbury, Conn., and Bridgeport Brass Co., Bridgeport, Conn.

While with Revere he was responsible for the development of the first continuous copper sheet rolling mill. He also developed the method for the automatic cutting of shell bands and made many contributions to further manufacturing methods of copper and brass products.

Irven Edwin Hanson, 64, chief engineer for Freeport Sulphur Co., died October 19.

Rising from the rank of rodman to that of chief engineer for Freeport, Mr. Hanson designed and constructed the first drilling rigs used by Freeport to lead the way in seeking Louisiana marshland surphur. He also constructed the first barge to transport liquid surphur.

Frank Eichelberger, 71, noted Spokane, Wash., mining engineer and former general manager of Sunshine Mining Co., died October 21.

During his long and outstanding mining career, Mr. Eichelberger worked in no less than ten different nations, and was associated with the construction of 16 different milling, smelting and metallurgical plants. His special interest in recent months was the operations of Conjecture Mines, Inc.

Mr. Eichelberger was general manager of Sunshine Mining Co. during its hey-day of development into the nation's leading silver producer. It was under his management that the Jewell shaft was sunk and the big surface plant built. In the early 1950's, he participated in the founding of American Chrome Co. for operation of the Mouat chrome mine near Columbus, Mont. In 1952 he went to the Far East as a mining advisor to the South Korean government.

John M. Kerr, 66, general manager of the Berwind-White Coal Mining Co., Windber, Pa., died October 24. He had been a hospital patient since suffering a heart attack in August.

William Wraith, Sr., 84, executive vice-president of the Andes Copper Mining Co., Chile Exploration Co. and vice-president of Greene Cananea Copper Co., subsidiaries of the Anaconda Company at the time of his retirement in 1946, died in Long Beach, Calif.

Mr. Wraith, a director of various other subsidiaries, continued to serve Anaconda several years after his retirement in a consulting capacity.

Widely known in Montana, he was an assistant engineer in 1897 for the Boston & Montana and the Butte & Boston Copper Companies, which were subsequently acquired by Anaconda. His early activities included erection of the first steel mine headframe in the Butte district and construction of the smelter at Anaconda. Later he became superintendent of the Anaconda Reduction Works.

Mr. Wraith left Anaconda in 1912 to go to the International Smelting & Refining Co. and in 1918 joined the administrative staff of Andes Copper Mining Co.

NEWS and VIEWS

Eastern and Central states

Clinchfield Merger Voted

Stockholders of the Pittston Co., a Richmond holding company, have approved a merger with the Clinchfield Coal Corp. of Clinchfield, Va., at a special shareholders meeting. Clinchfield stockholders were to vote on a proposal at the company's headquarters in Dante, Va.

Clinchfield, a western Virginia coal mining firm, has $15,983,180 in shares outstanding of a $20,000,000 maximum capitalization authorized by Virginia's State Corporation Commission.

Pittston, organized under the laws of Virginia and Delaware, has $957,734 in common stock and about $6,000,000 in preferred stock outstanding. It has a maximum authorized capitalization of $1,200,000 in common stock and $7,000,000 in preferred stock.

Pennsylvania Refuse Order

The Pennsylvania Sanitary Water Board has ordered all strip mine operators within the State to bury all coal refuse that could lead to acid pollution of streams. The new regulation applies to both anthracite and bituminous coal strip-mines where acid may be formed by the contact of water with the backfill of the completed mining operation.

The board said that acid-forming refuse materials, including "rider, rooster, blossom and honey" as well as other sulphur-bearing substances, must be separated from the rest of the spoil and spread along the bottom of the pit close to the base of the spoil pile along the low-wall side of the cut.

The regulation will require strip-mine operators to grade the top surface of the covering materials so that water will run off rather than soak into the backfill, thus preventing water from reaching the acid-forming refuse.

Joint Safety Committee

Joint safety committees have been formed at the Kaymoor, Minden, and Layland mines of the New River & Pocahontas Consolidated Coal Co. in Fayette County, W. Va. The committee at each mine consists of eight members, four of whom represent management and four the local UMW Union.

Prevention of injuries and promotion of safe work methods and practices are the objects of this joint action by union and management officials. The committees will propose safety programs which are subject to review and approval of top management of the coal company and the union's district office, together with the safety director of the UMWA International Union. They will investigate all phases of mine operations and promote compliance with company safety regulations, State and Federal mining laws, and the Federal Coal Mine Safety Act.

OSU Scholarships Awarded

Ohio State University's Mining Engineering Division has announced the establishment of six scholarship awards financed by North American Coal Corp., Cleveland, which operates mining properties in Ohio, West Virginia, and Pennsylvania. The program was initiated because of the critical shortage of mining engineers in the mining industry and the need to attract qualified young men into the profession.

Each student awarded a scholarship will receive a cost-of-living payment of $100 per month while he is enrolled in school; each freshman will be provided also with his fees and tuition. In addition, North American Coal guarantees summer employment.

Underground Mining at Crestmore

(Continued from page 36)

Power for the trucks is supplied by two General Electric Sealed Ignitron Rectifiers that are rated at 400 kw at 575 v with large overload characteristics. These rectifiers are protected for short circuits, prolonged overload, over heating and all types of electrical and mechanical failures. One is located on the surface and one half way down the haulage road. The entire trolley system is interconnected with feeder cables so that voltage drops are kept low. One rectifier can handle three trucks in an emergency.

Power for the rectifiers is supplied from the 2300-v, 50-cycle generating plant. Power is supplied to the underground rectifier and shovels by means of electrical cables through the old mine workings and diamond drill holes.

The General Electric underground sub-station, furnishing current for the shovels and auxiliary equipment, has full ground and overload protection.

Ventilation

Two Joy Axivane fans are used to exhaust through a three ft diam ventilation pipe serving the main tunnel. The fans each have 75-hp motors and exhaust 40,000 cfm of air. An additional fan is used to draw air through the 572 level. These fans exhaust through the old mine workings to the surface.

Auxiliary equipment used in this operation includes scrubber equipped D-8 cat, Allis-Chalmers grader and a Michigan skip loader. This equipment is used for clean-up and road maintenance.

For moving men and supplies an IHC 1½-ton diesel truck and a converted Autocar diesel flatbed are utilized.

Compressed air is furnished by two Ingersoll-Rand PRE-2 compressors located on the surface, through 8 and 10-in. air lines.

Canadian Option Exercised

Kennecott Copper Corp. has exercised its option to acquire 51 percent of Molybdenum Corporation's interest in a columbium deposit at Oka, near Montreal, Canada, the two companies have disclosed.

Exploratory work has confirmed the existence of a sizable deposit, although problems relating to mining, processing and marketing are still in investigatory stages.

Kennecott's interest in the Oka property and the granting of the option it has now exercised were disclosed in the summer of 1955.

In March last year, Marx Hirsch, chairman and president of Molybdenum Corp., described the Oka property as a major mineral discovery with huge indicated reserves. He said the company owned or had options on 7900 acres in the area and that the ore contained columbium-tantalum, iron and phosphorus and some uranium and thorium. It was estimated at that time it would cost between $3,000,000 and $4,000,000 and take two years to bring the property into production.

Zirconium Test Plant

Kennecott Copper Corp. will begin design and construction of a new test plant in the Cleveland area for the production of zirconium. The announcement by Charles R. Cox, Kennecott president, followed completion of licensing arrangements with Horizons Titanium Corp., Princeton, N. J. Kennecott acquired licenses for electrolytic production of zirconium and its by-product, hafnium. Kennecott also acquired options for licenses for electrolytic production of other metals, including titanium, thorium, columbium and tantalum.

A.C.S. Expansion

American Coal Shipping, Inc., and A. H. Bull Steamship Co. have agreed on a plan for ACS to acquire control of the Bull concern and its affiliates. The Bull fleet includes eight C-2 freighters, five Liberty ships and three Liberty collier ships that are designed specifically for hauling bulk cargoes such as coal.

Winding Gulf Output Rises

Coal production in the Winding Gulf Field is running more than 1,000,000 tons ahead of last year, according to a report of output by the 22 member mines of Winding Gulf Operators Association.

Officials reported that the output for the period from January to October was 6,169,063 tons, an increase of 1,064,676 tons or 20.8 percent over the 5,104,927 tons for the corresponding period last year.

To Convert Steel Plant

Titanium Metals Corp. of America, New York, has purchased the Louis Berkman Company's Ohio River steel division plant at Toronto, Ohio, and will convert the mill into the first specialized and exclusive facility for rolling and forging titanium.

Titanium Metals, owned jointly by National Lead Co. and Allegheny Ludlum Steel Corp., recently announced expansion of its Henderson, Nev., titanium sponge plant.

Standardization of Measurements

(Continued from page 44)

will be possible for all companies to compare figures that mean exactly the same thing; there would no longer be a need for conversion factors to check performance and costs. Earlier, the advantages of using this standard measurement at Climax were pointed out. These same advantages would be available to any and all properties using this same standard. That is—more accurate cost and performance reports, more accurate comparison of past work to current work, more accurate comparison of test results to production results, more accurate recommendations of the purchase of new equipment, more accurate control for a preventive maintenance program.

In addition to these gains, a common standard of measurement, if adopted by all companies, could mean:

(1) Increased value of all information exchanged between companies on drilling equipment.
(2) The elimination of an excessive amount of duplicate test work.
(3) Accurate direct comparisons of cost and performance of drilling equipment—under both test and production conditions.
(4) Earlier discovery of out-of-line costs on performance and therefore earlier correction of their cause.
(5) Increased value of recommendations for the purchase of new equipment.
(6) An important new source of information for manufacturers, and through their cooperation, an increased rate of development of improved equipment for all properties.
(7) Improved relationship in the industry.

Climax believes that this standardization is the first necessary step toward improved effiicency in any mining operation. It is the easiest way to gain the advantages listed above. When all companies use the same basic measurement, each operator can look forward to faster, more accurate answers to many of the drilling problems facing him today.

Climax realizes that changing to this method may be met with reluctance from the many companies that use a different method; that this change cannot be made overnight. However, this system has worked so well to give Climax the advantages listed above, that we believe it well worth the effort to make the change—a change that can improve costs and performance throughout the mining industry for each operator, whether he be large or small.

To Improve Cleaning Plant

Eastern Gas and Fuel Associates have closed a contract for improvement of its coal cleaning facilities at its Stotesbury No. 10 mine at Helen, W. Va.

The contract calls for installation of a fine-coal cleaning plant to prepare 150 tons per hour of ⅜-in. by 0 coal by air. A cyclone dust collecting system also will be installed, with completion scheduled for early next year.

Processing Plant Planned

The South Carolina State Development Board has announced that Orefraction Minerals, Inc., will construct a plant at Andrews for the grinding and processing of zircon, rutile and related minerals.

A two-story office building containing a laboratory and machine shop will be constructed, along with the 30,000 sq ft plant.

To Open Iron Mine

The M. A. Hanna Co., Cleveland, will open, as agents for Lowphos Ore, Ltd., a wholly owned subsidiary of National Steel Corp., an iron ore property at Moose Mountain, 35 miles north of Sudbury, Ontario, Canada. The low-grade iron ore at Moose Mountain will be mined by open-pit methods and concentrated into a high-grade product by a magnetic process. Planned production is 500,000 tons of concentrates annually.

Norway Silver Mine Closes

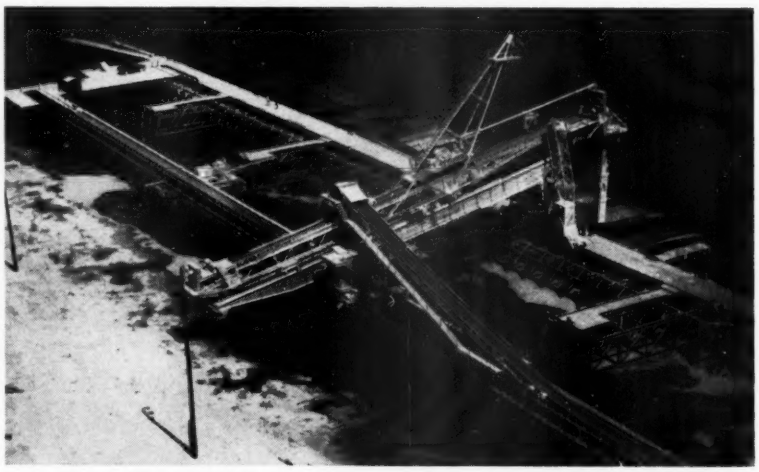
The Kongsberg, Norway, silver mining works, founded in 1624, has gone out of business. Owned by the government, it was the only mine in Norway producing silver. Parliament ordered it closed becaused it long had failed to show a profit.

Coal Shipping Mark Set

More coal was shipped out of Hampton Roads, Va., in both coastwise and foreign trade, this year by October 22 than during any full year in the history of the port. On that date, 41,341,457 net tons of coal had been dumped into ships at Norfolk and Newport News, bettering the record year of 1951 by more than 300,000 tons.

Through the first 21 days of October, coal dumpings at Hampton Roads were more than 150,000 tons ahead of September and totaled 3,354,518 tons.

Freeport Installs Novel Ship Loader



Freeport Sulphur Co. has placed in operation new dock facilities at Port Sulphur, La., designed to cut by one-half the average loading time for ships and barges.

A unique ship loader has been installed on an extension of Freeport's Mississippi River dock at a cost of over $1,000,000. This is the second part of a planned expenditure of $5,000,000 to improve the company's service to its customers.

The new loader, designed by Hewitt-Robins in collaboration with Freeport engineers, operates entirely by remote control. The loading operator, from his station on the deck of the ship, is able to move the loader and chute and control the ¾-mile conveyor belt system by means of a foot-square panel of buttons.

The giant machine travels a distance of 400 ft on two sets of double rails and moves from one ship's hold to another in less than five minutes as contrasted to a half hour or longer if the ship had to be moved. The discharge chute, made to "throw" the sulphur 20 ft in any direction, shuttles out to 45 ft from the dock and can clear an elevation of 54 ft.

Last year Freeport installed facilities to load sulphur in molten form for shipment by water to customers many hundreds of miles away. These installations have since been enlarged to meet the growing demand from consumers for this new method of delivering sulphur.

Pitt-Consol Deal Authorized

Stockholders of the Pittsburgh Consolidation Coal Co. have approved the proposed purchase of at least 85 percent of the outstanding common stock of the Pocahontas Fuel Co., Inc., Pocahontas, Va. Voted in favor of the proposal at the special stockholders' meeting were 93 percent of the company's outstanding shares.

The proposal calls for Pitt-Consol to exchange 2⅝ shares of its authorized but unissued stock for each share of Pocahontas outstanding common stock. Under the plan, Pitt-Consol may purchase all but not less than 85 percent of Pocahontas stock.

The stockholders also approved an increase in Pitt-Consol authorized capital stock from the present 9,000,000 shares to 12,000,000 shares of common stock at a par value of one dollar a share.

Pitts-Consol is the world's largest coal producing firm, with mines in western Pennsylvania, Ohio, northern West Virginia and eastern Kentucky.

Pocahontas operates low volatile coal mines, principally in southern West Virginia and Virginia.

Titanium Dredge Constructed

Hobart Brothers Co., Troy, Ohio, has developed and produced a huge dredge for the mining of titanium in Florida. A bucket-type dredge somewhat similar to those used in gold mining, it will handle enough sand to produce 200 tons of titanium a week.

The company has been working on titanium production at Winter Beach, Fla., 200 miles south of Jacksonville, over a four-year period.

Wheels of Government

(Continued from page 73)

tempts to obtain funds from other sources failed and the tungsten buying plan came to a halt early this month. The Administration plans to seek early action on new funds, but with the new Congress in the throes of organization, it is not expected that the program will again be financed until some time in February or March.

Funds earmarked for buying fluorspar, asbestos and columbium-tantalum could not be shifted to the tungsten purchase program. Interior Department officials indicated that these funds would also be expended rapidly.

Safety Hearings Being Held

A special Mine Safety Subcommittee of the House Labor Committee is holding hearings in Washington on a number of measures which would authorize Federal inspection of metal and nonmetallic mines and quarries for the purpose of obtaining information on health and safety conditions and as a basis for future legislative recommendations. Rep. Lee Metcalf (Dem. Mont.), chairman of the subcommittee, has stated that new measures, based on the testimony taken at the Washington hearings and at previous field hearings in Minnesota, Montana and Colorado, will be drafted and introduced early next year.

Heavy opposition to the bills before the subcommittee has been registered throughout all branches of the mining industry affected by the proposals. At the Washington hearings, representatives of the American Mining Congress will urge Congress not to enact any such legislation. They will point out that the metal and nonmetallic mining industries have an excellent safety record, that management has constantly sought to improve this record, that State mine inspection has proved highly successful in the attainment of safer working conditions and practices, and that any necessary governmental regulations should properly come from the States. The AMC witnesses will also call for the U. S. Bureau of Mines to continue and expand its activities toward developing and disseminating improved techniques in mine accident prevention and safety education and ask that adequate funds be provided for this purpose.

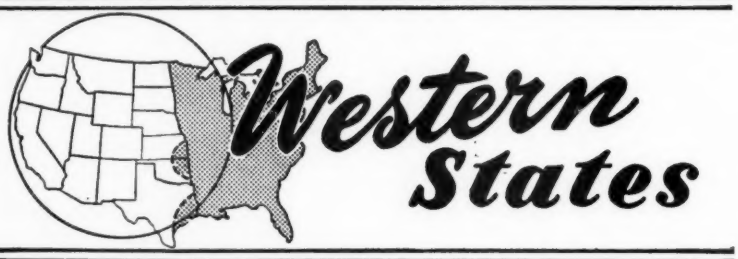
Representatives of State mining organizations and mineral producers are also expected to testify or submit their views on the pending proposals.

If the Administration adheres to the position it has already voiced on the mine safety proposals, they face tough sledding in the new Congress. The Departments of Interior, Labor and the Bureau of the Budget at the last session submitted adverse reports, indicating that safety regulation was a matter for the States to handle, with the possibility that the Federal Government might assist them through some form of financial aid.

Ohio Salt Mine

The Morton Salt Co. plans to sink two shafts for the mining of salt near Painesville, Ohio, about 30 miles northeast of Cleveland. One, a 16-ft circular shaft, will be used for production, while the other, a 10-ft shaft, will be used to handle men and materials.

The Winston Bros. Co. is currently carrying on an exploratory drilling program in the area.



New Cobalt Refinery

Howe Sound Co. has started construction of a $750,000 electrolytic cobalt refinery near its present cobalt processing plant at Garfield, Utah. The facility is expected to be in operation late in 1957.

The new refinery will produce about 8000 lbs daily of very high specification cobalt metals in the form of cathodes. The present refinery produces cobalt shot or granular material from concentrates produced at Calera Mining Company's Cobalt, Idaho, mill and mine.

Howe Sound's central research laboratories at Salt Lake City developed new approaches to cobalt refining, which made establishment of the new plant possible. Most of the engineering and construction work will be handled by Calera's staff at Garfield.

Wyoming Safety Code

A committee of the Wyoming Mining Association met recently in Riverton, Wyo., to study existing state laws on mine operations and to draft a safety code for non-coal mines, to be submitted to the State Legislature.

Russell W. Beamer, executive secretary, said that the Wyoming Mining Association "keenly feels its responsibilities not only to the mine operators but also to their employes and communities in which they are located." Fourteen mining firms were represented at the initial meeting. Roy Coulson, Vitro Minerals Corp., Riverton, is chairman of the code-drafting committee.

Zirconium Research

The U. S. Bureau of Mines has started a research project, financed by the Atomic Energy Commission, to develop a method for recovering zirconium from impure sponge metal, mill scrap, and zirconium alloys, according to Secretary of Interior Fred A. Seaton. The research will be conducted at the Bureau's Boulder City, Nev., experiment station and will emphasize an electro-refining process.

Zirconium's strength and corrosion resistance, plus the fact that it does not absorb atomic particles needed to sustain a chain reaction, have made it an essential construction material for atomic furnaces. Virtually all present zirconium production in the United States is consumed by AEC.

Metallurgists at the Boulder City station will use techniques developed in the Bureau's pioneering research on electrorefining of titanium metal to guide them in designing the electrolytic cell for zirconium recovery.

Con-Virginia Diversifies

Consolidated Virginia Mining Co. of San Francisco has acquired Hampton Mining Co., a Utah corporation holding interests in a Panama oil concession near a recent discovery there by the Union Oil Co. of California.

Vitro Expands Mill

Vitro Uranium Corp. and the Atomic Energy Commission have announced signature of contracts leading to an expansion of Vitro's Salt Lake uranium mill.

Under the contract, Vitro will spend $1,200,000 in conversion of its present phosphate precipitation circuit at the mill to a solvent extraction process.

W. B. Hall, Vitro uranium general manager, said the new contract would permit Vitro to "expand its policy of purchasing ores from independent mines" in the West.

Sulphur Exploration Plant

Texas Gulf Sulphur Co., Houston, Tex., is planning to drill a number of test wells off Galveston Island to explore for sulphur. The firm holds State leases on six tracts lying off the western part of the island.

Texas Gulf has applied to the U. S. Army Corps of Engineers for blanket permission to set up off-shore drilling platforms in locations which will not interfere with navigation.

Chemical-Mining Conference

THE West's first Chemical-Mining Inter-Industry Conference was held on November 9 in San Francisco's Fairmont Hote by the San Francisco Chamber of Commerce. Two hundred and fifty leaders of both industries from at least five of the Western States attended the meeting.

Delegates—top executives of many of the West's most important mining companies and chemical processing firms—heard experts in both fields describe new ways in which each industry can profit more through use of the other's products. They also heard latest figures on mineral production in the Western States and looked at future mineral developments.

The Conference, arranged by the San Francisco Chamber's Chemical Industries Section and Mining Committee, opened at 9:15 a. m. with welcoming remarks by E. W. Littlefield, president of the Chamber, who had just returned from Australia. That country, he said, "is a fine example, by way of contrast to our own situation, of a land of rich potential that has not yet received the great benefits that result from a full development of the mining and chemical industries."

Objectives of the day-long conference were (1) to show how the chemical industry can best aid the needs of mining, (2) to describe how the mining industry can best meet the requirements of chemical processing and (3) to develop better understanding and appreciation of the problems of each and coordinate their efforts for mutual benefit and for the greater growth of western resources.

The mining industry was well represented at the Chemical-Mining Inter-Industry Conference. M. P. Romney, Secretary of the Utah Mining Association, John C. Lokken, Manager Mining Chemical Sales, Dow Chemical Co., S. H. Williston, Vice-President, Cordero Mining Co., and Jack How, President of Western Machinery Co., (left to right above) took part in the program

Uranium Ore Deposits Purchased

Union Carbide Nuclear, a division of Union Carbide & Carbon Corp., has purchased certain uranium deposits in the Craig-Maybell area of the Colorado Plateau, located about 100 miles north of Rifle, Colo., and owned by Trace Elements Corp. At the same time, the Atomic Energy Commission announced signature of a mill contract with Trace Elements for erection of a concentrator at Maybell in Moffat County, Colo. Construction of the mill will start immediately and will be completed in 12 months.

A. Q. Lundquist, general manager of Colorado Plateau Operations of Union Carbide Nuclear, said that the new ore reserves "will be used, in part, to meet Carbide's obligation to the Atomic Energy Commission under its recently announced contract covering the Rifle mill as well as for many milling operations to be effected in the Craig area." Lundquist, while not confirming a report that Nuclear had purchased all of the outstanding common stock of Trace Elements, said that "the purchase of ore reserves makes financing of the Maybell mill possible."

Union Carbide earlier this year signed a contract with AEC for a new mill at Rifle to be served by two chemical up-grading operations at Slick Rock, Colo., and Green River, Utah.

Sinking East Tintic Shaft

Bear Creek Mining Co., domestic exploration subsidiary of Kennecott Copper Corp., has selected Centennial Development Co. as contractor for sinking a 1020-ft prospect shaft in East Tintic lead-silver-zinc district. The 2½ compartment, rectangular shaft is expected to be completed within nine months.

Bear Creek will then drill, drift and cross-cut in exploration radiating from the shaft. Three separate mineralized areas reportedly have been encountered by core and churn drilling in East Tintic. Bear Creek is operator of the East Tintic Unit of which Chief Consolidated Mining Co. and the Tintic group of companies are major participants.

The shaft will be located on ground of the Apex Standard Mining Co., an affiliate of Chief Consolidated.

Lucky Mc Signs U-Mill Contract

The United States Atomic Energy Commission and the Lucky Mc Uranium Corp. of Salt Lake City have signed a contract for the construction and operation by Lucky Mc of a uranium processing mill in the Gas Hills area of Fremont County, Wyo.

The proposed site of the mill is approximately 50 miles southeast of Riverton, Wyo.

Construction of the new mill is expected to begin immediately, with completion scheduled in about 12 months.

Design and engineering for the plant were performed by the Utah Construction Co., a principal stockholder of Lucky Mc. During the past 14 months the company has completed an extensive exploration in the district, involving several hundred thousand feet of drilling.

In addition to processing uranium ores from properties owned or controlled by Lucky Mc, some amenable ores will be purchased from independent producers of the Gas Hills area.

New Mexico Publications

The New Mexico Bureau of Mines and Mineral Resources has issued an up-to-date list of publications, bulletins, circulars, charts and maps, available at this time. In addition to publications and maps prepared by the State Bureau, the list includes numerous publications of the U. S. Geological Survey, and other organizations relating to the geology of New Mexico. A copy of the list may be obtained from the Bureau at Campus Station, Socorro, N. M.

Wyoming Aluminum Reduction

Reynolds Metals Co. has announced that it has picked up its option on a 4000-acre tract adjacent to Lake Desmet, Wyo., looking to the possible construction of an aluminum reduction plant. Walter L. Rice, president of Reynolds Mining Corp., a subsidiary, said the company plans to take possession soon. He said the tract covers an unusually large seam of coal measuring more than 100 ft in thickness which lies comparatively near the surface.

Rice said that the coal—graded as sub-bituminous—and the ample water supply from the lake provide the essentials for steam generation of electricity. Reynolds also has an option on a larger adjacent tract but this one has some time to run. The area is near Sheridan, Wyo.

Montana Flotation Mill

Plans for a 100-tpd selective flotation mill to be installed at the Montana Standard mine near Thompson Falls, Mont., were announced by Loy L. Vose, president of Montana Standard Mining Co., Ltd.

When completed, the new mine-mill operation will employ about 20 persons. Ore processed into concentrates will be sent direct to smelters at Kellogg, Idaho, or East Helena, Mont., Vose said. In addition to the mill, the firm plans to sink the shaft an additional 200 ft in an effort to materially increase ore reserves.

Ammonia Contract

Anaconda Co. has signed a contract to purchase substantial quantities of anhydrous ammonia from United States Steel Corporation's new $18,000,000 coal chemical plant near Provo, Utah.

The anhydrous purchased from Geneva Works of the steel company will be used at Anaconda, Mont., for the production of "ammo-phos," an ammonium phosphate fertilizer.

Idaho Silver-Lead Resumes

Whitedelf Mining & Development Co. has resumed production at its silver-lead mine near Clark Fork, Idaho, following completion of a $260,000 exploration program. Ore is presently being taken from the north drift on the new 800-ft level. It is now planned to add to the present crew and start mining from the south drift and to put the 50-ton mill on a two-shift basis.

The three-year exploration program was accomplished under a contract with the Defense Minerals Exploration Administration. The shaft was deepened 430 ft and 1500 ft of tunnel driven northerly and 1100 ft southerly. Ore shoots were cut by each drift.

Phosphate Expansion

San Francisco Chemical Co. has announced a $2,000,000 expansion program at Leefe, Lincoln County, Wyo., to improve the efficiency of mining thin-bedded phosphatic deposits in the Intermountain area.

San Francisco has a 1000-tpd beneficiation plant under construction at Leefe. The facility will up-grade the material mined from the "C" beds, and will also treat the higher grade mixtures from the "A" and "B" beds in the area. The new concentrator will employ "hydro-metallurgical methods," according to D. L. King, president and general manager for San Francisco at Montpelier, Idaho.

Bids Made on Tin Smelter

The government's Federal Facilities Corp. has received two bids to buy the Longhorn tin smelter at Texas City, Tex., Built in 1941-42 as a wartime emergency project, the tin smelter is the only one of any substantial size in the Western Hemisphere. Last session Congress ordered the smelter to be disposed of by next January 31, with a November 1 deadline for bids from private buyers.

One proposal to buy the plant came from Wah Chang Corp., New York. The other was submitted by Ellis E. Patterson and S. Fishfader, Los Angeles, on behalf of a group of interested parties. FFC officials declined to disclose the amounts of the two bids, but said the government is now negotiating with the two bidders and the ultimate price paid might differ from the original proposals. Negotiations are due to be completed no later than December 27.

The Government's original investment in the property, plant and equipment of the smelter and waste acid plant amounted, with additional capital expenditures, to about $13,000,000. Officials said the depreciated value by next January 1 should be around $5,000,000.

Canadian Lithium Plant

The Department of Industry and Commerce of the Canadian Province of Manitoba has announced that recent technical progress may soon result in the development of more than 12,000,000 tons of lithium ore in southeastern Manitoba.

The department said that one of the three companies which have taken up claims in the area has already spent more than $1,000,000 in development and expects to spend an additional $5,000,000 before its mine goes into production in the fall of 1958.

The Manitoba Government has contributed in the construction of a $250,000 road into the district, centered near the Cat Lake-Bernic Lake area, and has also built a $100,000 electric power line to supply needed electricity.

The district is 65 miles northeast of Winnipeg.

Idarado Closes Mill

The Idarado Mining Co. closed its Red Mountain mill, crushing plant and assay office on November 30. Now all underground ores are transported to the Telluride side of the San Juan range and processed in the company's Pandora mill.

The San Juan divides Idarado's two surface installations, which are linked by underground workings. The decision to close the eastern plant was "based on the fact that it will be better to operate one mill at full capacity than two mills at part capacity each."

Sixth Annual Drilling and Blasting Symposium

THE SIXTH Annual Drilling and Blasting Symposium, sponsored by the School of Mines and Metallurgy and the Center for Continuation Study of the University of Minnesota in cooperation with the Mining Sub-division of the Minnesota Section AIME, was held on the University campus on October 11-13. The meeting, attended by some 175 registrants and faculty, was devoted to the interexchange of ideas that would hasten the new developments in solving the problems attached to drilling and blasting of taconites and other hard rocks.

Subjects that came under discussion were the interesting research work done on percussive drilling of rock and indicated its application in design and use of new equipment, the principles of both rotary and percussive drilling, the new rotary-percussive technique of drilling rock, and the use of the tungsten carbide "button type" rotary bits for drilling in taconites.

An afternoon session centered on basics of blasting hard rock, and the operating side of the picture was ably presented by a group of experts who live with the problem from day to day on the Iron Ranges, as well as the iron titanium operations in New York and the quarrying operations of Georgia.

The final session highlighted the description and operating experience of the new continuous tunnel boring equipment developed for use in driving the 28-ft diameter tunnels through shale for the Oahe Dam project in South Dakota, and concluded with a general discussion of several new drilling and blasting techniques.

The papers will be published in forthcoming Proceedings of the Symposium, which may be purchased within the next three months, from the Center for Continuation Study at the University of Minnesota.

First Concrete Placed in New Highway Program

A CAREFUL CHECK of reports from over the United States indicates that the start of America's 13-year highway construction program—the biggest peacetime construction job in history—became a concrete reality on Wednesday, September 26, near Tokepa, Kans., when pavers laid the first section of heavyduty highway to be built with funds provided under the 1956 Federal-Aid Highway Act.

Reports from the 1st Division, Kansas State Highway Department, show that on that date dual paving machines of the Koss Construction Co., Pauline, Kans., deposited and finished the first concrete pavement of an eight-mile section of U. S. Route 40, west of Tokepa. Upon completion, this highway will become part of the 41,000-mile National System of Interstate and Defense Highways, the heavyduty "highway network of the future." The Highway Act of 1956, passed by Congress on June 29, authorized nearly $25 billion in Federal funds for the construction of these Interstate highways over the next 13 years, and the Kansas pavement is believed to be the first constructed using these new funds.

El Salvador Copper Plan

The Anaconda Company's subsidiary, Andes Copper Mining Co. has outlined a new, expanded plan for mining and beneficiating the copper ores of its new El Salvador mine project in Chile. The ore bodies to be mined are located near the Indio Muerto Mountain some 18 miles north of Potrerillos. Under the provisions of Chile's new copper law, the plan if approved will result in investment of a total of $80,150,000, an increase of $27,200,000 over the total investment planned initially.

Last March, Andes Copper was granted authority to invest $52,950,000 to develop the El Salvador Mine Project, and to make welfare improvements in Potrerillos where the ore was to be treated. Since then, exploration drilling, and tunneling have proved additional tonnages of ore. The original estimate of 78,000,000 tons averaging 1.6 percent copper based on drilling up to that time, already has been increased to approximately 200,000,000 tons averaging 1.6 percent copper by additional drilling completed since that date. Prospect drilling is still continuing under conditions favorable to the development of more ore.

Andes Copper has concluded that its original plans for bringing the mine into production should be adjusted to the larger ore reserve tonnages, and that the new design should be more flexible than the original.

The present plans provide for the development of the deposit in the Turquoise Gulch area as an underground mine. Into this mine there will be driven a main haulage tunnel which will be electrified for the haulage of the ore to the concentrator. Two adits will be driven on mining levels to facilitate mine development.

The surface installations proposed will consist of transmission lines and water lines into the property, the construction of primary and secondary crushing plants near the main tunnel portal as well as the construction of a concentrator including ore bins, fine grinding equipment and the most modern flotation installations. Copper concentrates will be pumped through a five-in. pipeline 15 miles to Pastos Cerrados, a point on the Potrerillos Railway. Here they will be filtered, and then transported by railway to the Potrerillos smelter.

At El Salvador the plans provide for the construction of a town near the mine embodying the various features required for a modern village. Besides up-to-date dwellings the plans contemplate a well equipped theater, an employes club, schools, hospital, church, stores and various other welfare projects such as playgrounds and athletic fields.

Total cost of this revised plan is estimated to be $80,150,000 of which $33,855,000 would be spent in Chile and $46,295,000 spent outside of Chile for machinery and supplies.

Projected installations, combined with the nearby existing smelter at Potrerillos are expected to provide an estimated annual capacity for production of about 100,000 short tons of fine copper. Earlier this year Andes Copper revealed that the ores of its present Potrerillos mine would be exhausted in four to five years, and that a like period would be required to bring into production the ores of the El Salvador mine. The new plans provide that full production from El Salvador will be realized by the end of 1959.

South Dakota Cement

The South Dakota State Cement Commission has approved an $800,000 improvement at its Rapid City plant and will also transfer $1,500,000 to the state general fund on December 15. Gov. Joe Foss has approved the expansion.

New Mexico Magnetite

The Magnetite Corp. has started operations on an open pit mine in the vicinity of Capitan, N. M. About 25 men are currently engaged in mining and crushing magnetite iron ore, which is used as a heavy aggregate in coating underwater pipelines.

Sulphur Firm to Expand

Jefferson Lake Sulphur Co., Houston, Tex., is planning a two-part $5,500,000 expansion on the Houston Ship Channel. The company is looking for a channel site for a $3,500,000 petrochemical plant and is programming a $2,000,000 expansion of its plant in Green's Bayou to double the latter plant's capacity.

The expansion will increase the plant's capacity to approximately 300,000 gal a month of cresylic acid and phenol, as well as 1000 tons of sodium sulphide per month.

Australian Rutile

Australia's coastal beaches are now producing the world's largest supply of rutile, source of titanium, with 1955 production totaling more than 50,000 tons. This compares to 10,000 tons produced by the United States and 24,000 tons by Mexico, the other two major sources.

Australian rutile is derived from black sands just below the surface of the countless beaches which line that country's coast.

Rutile recovery has become one of the two most important mineral developments in Australia. Uranium is the other.

National Lead, a U. S. company, is playing a leading part in the "down under" country's rutile operations.

Manufacturers Forum

Sump Pump

THIS AIR OPERATED sump pump is rated at 340 gpm against a ten-ft head and is available in either steel or bronze. It operates with a maximum head of 95 ft, has a base diameter of

eight in. and is 23 in. high. It has an air inlet of ¾ in. in diameter, while the discharge outlet is 2½ in. in diameter. Net weight of the steel model is 56 lb and the bronze, 75 lb. Request additional data from the Sales Promotion Department, Le Roi Division, Westinghouse Air Brake Co., Milwaukee 1, Wis.

Time Switch

WITH A MULTI-TRIPPER DIAL for flexibility of time setting, the TSA-555 general purpose time switch may be used wherever many varied on-off schedules are required during a 24-hour period. Minimum on time can be as short as 15 minutes with a minimum on-off cycle of 45 minutes.

When the time switch is used with a contactor or normally open interlock, the optional intermittent contacts provide undervoltage protection and automatic sequence restarting in the event of power failure.

Voltage for the new timing device is 120, 240, 480 and frequency is 60, 50, or 25 cycles. Power source is a four-watt Telechron motor.

An omitting device can be furnished with the switch. It is said that operations on any day of the week can be omitted repeatedly.

A descriptive bulletin, designated GEC-1406, is available from the News Bureau, General Electric Co., Schenectady 5, N. Y.

Respirator

PROTECTION AGAINST minute particles, including radioactive dust and air-borne organisms, is provided by the new Dustfoe Ultra-Filter Respirator, according to the Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.

Combining features of the MSA Ulra-Filter Respirator with the MSA Dustfoe Respirator facepiece, the unit weighs only six oz complete with headband. The aluminum facepiece can be easily formed by the fingers to fit the contours of the wearer's face. A soft cushion completes the seal and provides additional vision

For further information, write for Bulletin No. 1004–2.

Inquiries about new equipment appearing in Manufacturers Forum are welcomed. For additional information on any piece of equipment in this section write directly to the manufacturer, or to Mining Congress Journal with name of item and date of issue in which it appeared.

Wire Rope Clips

WITH 16 SIZES AVAILABLE for wire rope diameters from ⅛ up to 1½ in., these wire rope clips, marketed under the trade name of Canton, are offered in plain self-colored finish, cadmium plated or hot dip galvanized. The U-bolt portion is heavy steel with malleable saddle shaped to fit wire rope strands. Write to Canton Mfg. Co., 2408-13th St. N. E., Canton 5, Ohio, for more data.

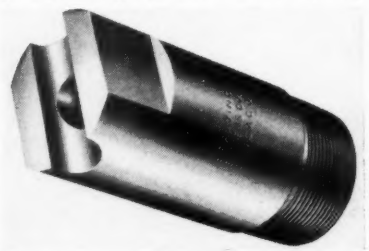
Lightweight Drill

THIS SELF-CONTAINED DRILL has a total weight of 53 lb and is equipped with Sandvik Coromant steels. The one-cylinder, double-stroke, free-wheeling motor has a pull type starter and floatless carburetor that permits inclined drilling positions up to 45°. An integral compressor provides 100 percent air flushing of drilling mechanism channels. Steel changes or conversion of the drill to a rock-pavement breaker is rapidly accomplished, according to the company.

Illustrated literature on the "Cobra" may be obtained from Atlas Copco Pacific, Inc., 930 Brittan Ave., San Carlos, Calif.

Spray Nozzle

DESIGNED FOR HEAVY DUTY cooling and washing operations, the 2-U-Veejet nozzle is also suitable for other applications where a large capacity flat spray is desired. Capacity



of this nozzle ranges from 73 gpm at 15 psi to 330 gpm at 300 psi. It is supplied in choice of two types of spray angles. Made standard in brass with a two-in. male pipe connection, it can be supplied in other materials upon order. Write for Data Sheet 6868 to Spraying Systems Co., 3201 Randolph St., Bellwood, Ill.

Diesel Electric Set

A 100-KW SELF-REGULATED diesel electric set has been added to the expanding line of Caterpillar-built power generating equipment, according to the Caterpillar Tractor Co., Peoria, Ill.

Known as the Cat D342 Electric Set, the unit uses a self-regulated generator to make available the principal advantages of previous self-regulated and externally-regulated generators in one package.

Eucs prove best investment . . .

for WYANDOTTE CHEMICALS CORP.

33,000 hours . . . still going strong!

At Alpena, Michigan, Wyandotte Chemicals Corp. has one of the world's largest limestone quarries—another job where "Eucs" are paying off in more loads per hour at less operating and maintenance cost.

Nine years ago Rear-Dump Euclids of 22-ton capacity replaced an electric haulage system for moving rock from the quarry face to the plant. These 14 "Eucs" are loaded by shovels with 5 and 6 yd. buckets. Average hourly production of each Euclid on the two-mile round trip is 75 tons on a 'round the clock schedule seven days per week. Company records show that they've worked an average of 33,000 hours each and more than 4 million ton-miles per unit.

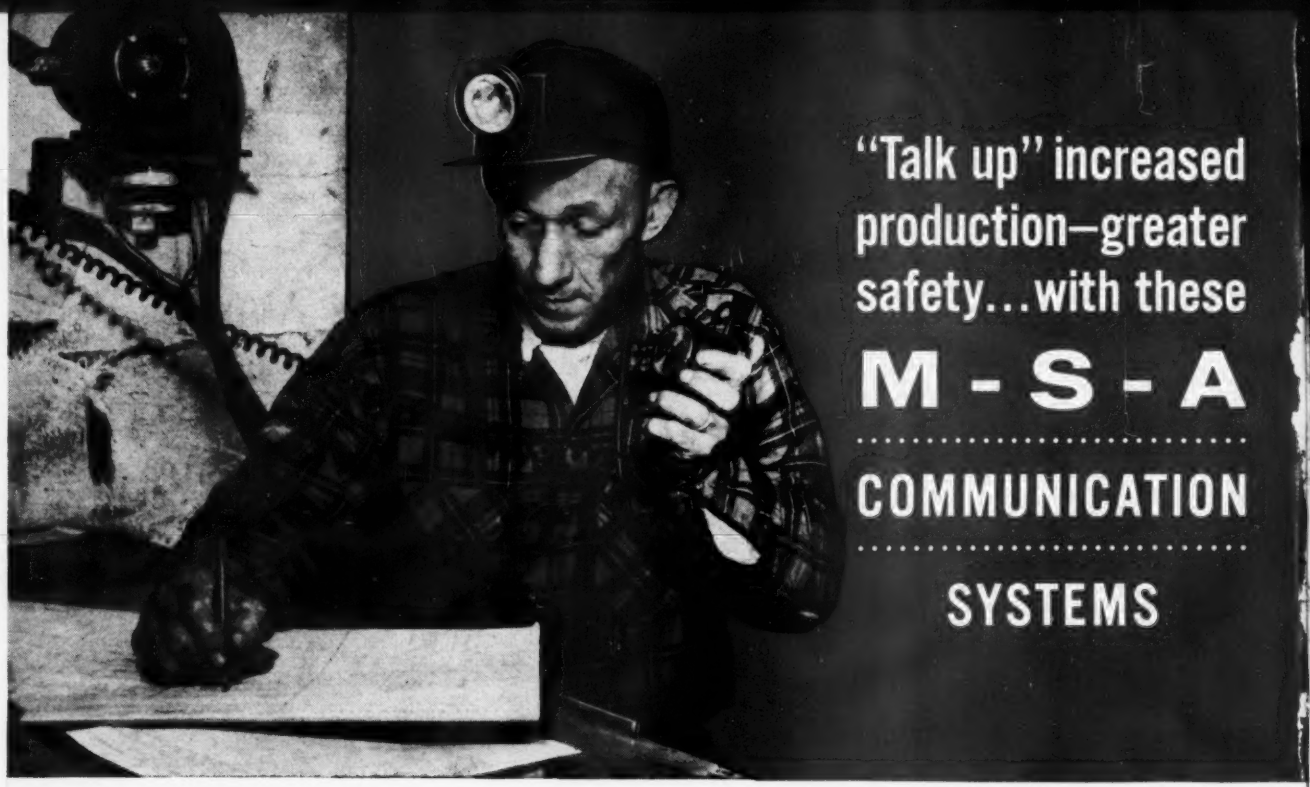
Wyandotte standardized on Rear-Dump Euclids because of their job-proved dependability on hundreds of mine and quarry operations. Performance on the job and 9 years of experience prove this decision has paid off because "Euc" speed, efficiency and long life have increased production and lowered hauling costs for Wyandotte.

Your nearby Euclid dealer will be glad to discuss your off-the-highway hauling problems and show you why ***Euclids are your best investment.***

EUCLID DIVISION, GENERAL MOTORS CORPORATION, Cleveland 17, Ohio

Euclid Equipment

FOR MOVING EARTH, ROCK, COAL AND ORE



"Talk up" increased production—greater safety...with these M-S-A COMMUNICATION SYSTEMS

M-S-A MINEPHONE

Dispatcher sends orders instantly and simultaneously to all motormen with this modern, underground two-way voice communication system. Motormen receive and reply while trips are in motion—keep haulage movements coordinated with production demands. This results in smoother, faster, and more continuous trip movements throughout the mine.

Messages clear tracks for outgoing loaded trips and incoming empties. This system puts an end to traffic tie-ups, errors and accidents; prevents excessive stop-and-start strain on equipment. Write for more detailed information.

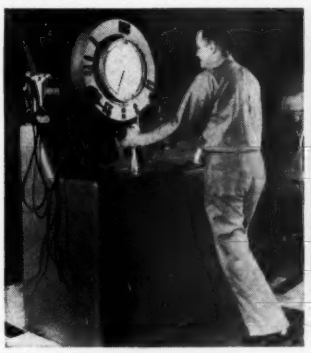
• Dispatcher sends orders to motormen . . . routes right-of-way traffic . . . receives reports on positions and station conditions.

• "Jeep" operator requests instructions from dispatcher and maintenance shop for section assignment . . . speeds emergency repair.

M-S-A HOISTPHONE

For accurate, instant response between the hoisting engineer and cage, here's the voice communication system to install. Whatever the job—load leveling—shaft repairs—shaft inspection trips—passenger transportation—the M-S-A HoistPhone provides better safety and efficiency through dependable, continuous two-way voice communication at any level, and while the cage is in motion.

Requires no special training . . . simple to use . . . dependable in operation. Write for further information.



• The hoisting engineer is able to control all movements of the cage by communicating with cage rider over the M-S-A HoistPhone.

• Worker uses microphone in cage to tell the hoisting engineer where he wants to go. Loudspeaker mounted on top of cage.

MSA

SAFETY EQUIPMENT HEADQUARTERS

When you have a safety problem, M-S-A is at your service . . . our job is to help you

MINE SAFETY APPLIANCES COMPANY

201 North Braddock Avenue, Pittsburgh 8, Pa.

At Your Service: 77 Branch Offices in the United States and Mexico

MINE SAFETY APPLIANCES CO. OF CANADA, LTD.

Toronto, Montreal, Calgary, Edmonton, Winnipeg, Vancouver, Sydney, N.S.